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Savannah District

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**Divisions 6 through 16**  
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**U.S. ARMY ENGINEER DISTRICT, SAVANNAH  
CORPS OF ENGINEERS  
100 WEST OGLETHORPE AVENUE  
SAVANNAH, GEORGIA 31401-3640**

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## SECTION 06100

## ROUGH CARPENTRY

**09/99**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |                 |   |
|-----------------|---|
| ANSI B18.2.1    | (1996) Square and Hex Bolts and Screws<br>Inch Series       |
| ANSI B18.5.2.1M | (1981; R 1995) Metric Round Head Short<br>Square Neck Bolts |
| ANSI B18.6.1    | (1981; R 1997) Wood Screws (Inch Series)                    |

## APA - THE ENGINEERED WOOD ASSOCIATION (APA)

- |          |  |
|----------|--|
| APA E445 | (1996) Structural-Use Panels (APA PRP-108) |
| APA F405 | (1995) Performance Rated Panels            |

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- |                      |   |
|----------------------|---|
| ASME/ANSI B18.2.2    | (1987; R 1993) Square and Hex Nuts (Inch<br>Series)   |
| ANSI/ASME B18.5.2.2M | (1982; R 1993) Metric Round Head Square<br>Neck Bolts |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |   |
|-------------|---|
| ASTM A 687  | (1993) High-Strength Nonheaded Steel Bolts<br>and Studs |
| ASTM F 1667 | (1995) Driven Fasteners: Nails, Spikes,<br>and Staples  |

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

- |         |  |
|---------|--|
| AWPA C1 | (1996) All Timber Products - Preservative<br>Treatment by Pressure Processes                           |
| AWPA C2 | (1996) Lumber, Timbers, Bridge Ties and<br>Mine Ties - Preservative Treatment by<br>Pressure Processes |
| AWPA C9 | (1996) Plywood - Preservative Treatment by<br>Pressure Processes                                       |

AWPA C20	(1996) Structural Lumber - Fire-Retardant Treatment by Pressure Process
AWPA C27	(1996) Plywood - Fire-Retardant Treatment by Pressure Process
AWPA M2	(1996) Inspection of Treated Timber Products
AWPA M6	(1996) Brands Used on Forest Products

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1923	(Rev. A) Shield, Expansion (Lag Shield)
CID A-A-1924	(Rev. A) Shield, Expansion (Self Drilling Tubular Expansion Shell)
CID A-A-1925	(Rev. A) Shield Expansion (Nail Anchors)

## FEDERAL SPECIFICATIONS (FS)

FS FF-B-588	(Rev. E) Bolt, Toggle: and Expansion Sleeve, Screw
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## U.S. DEPARTMENT OF COMMERCE PRODUCT STANDARDS (PS)

PS-1	(1995) Construction and Industrial Plywood
PS-20	(1970; R 1986) American Softwood Lumber Standard

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures":

SD-06 Test Reports

Preservative-treated lumber

## 1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Remove defective and damaged materials and provide new materials.

## 1.4 GRADING AND MARKING

## 1.4.1 Lumber

Mark each piece of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used.

#### 1.4.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark shall identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with PS-1.

#### 1.4.3 Preservative-Treated Lumber

The Contractor shall be responsible for the quality of treated wood products. Each treated piece shall be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor shall provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

#### 1.4.4 Fire-Retardant Treated Lumber and Plywood

Mark each piece in accordance with AWPA M6. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

#### 1.5 SIZES AND SURFACING

PS-20 for dressed sizes of yard and structural lumber. Lumber shall be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

#### 1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products shall be as follows at the time of delivery to the job site:

- a. Lumber and Boards: 19 percent maximum.
- b. Materials Other than Lumber: Moisture content shall be in accordance with standard under which the product is produced.

#### 1.7 PRESERVATIVE TREATMENT

Treat lumber and timber in accordance with AWPA C1 and AWPA C2, and plywood in accordance with AWPA C1 and AWPA C9. All wood shall be air or kiln dried after treatment. Specific treatments shall be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. The following items shall be preservative treated:

- a. All lumber used in conjunction with roofing and roof associated sheet metal.



b. As indicated on drawings.

c. Lumber and plywood in contact with concrete or masonry.

#### 1.8 FIRE-RETARDANT TREATMENT

Treat plywood backboards in electrical and communications closets in accordance with AWPA C20 or AWPA C27.

### PART 2 PRODUCTS

#### 2.1 LUMBER

All lumber shall be No. 2 Southern Pine or an approved equivalent species and grade as approved by the Contracting Officer.

#### 2.2 PLYWOOD

PS-1, APA E445, and APA F405, respectively.

##### 2.2.1 General Use

C-D Grade, Exposure 1 durability classification, and a minimum thickness of 3/4 inch except where indicated to have a different thickness.

##### 2.2.2 Electrical Backboard Plywood

A-C Grade, Exposure 1, Fire Retardant Treated, and a minimum thickness of 3/4 inch.

#### 2.3 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood or concrete walls or slabs shall be zinc-coated.

##### 2.3.1 Bolts, Nuts, Studs, and Rivets

ANSI B18.2.1, ANSI B18.5.2.1M, ANSI/ASME B18.5.2.2M, ASME/ANSI B18.2.2, and ASTM A 687.

##### 2.3.2 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices shall be 3/8 inch.

##### 2.3.3 Lag Screws and Lag Bolts

ANSI B18.2.1.

##### 2.3.4 Toggle Bolts

FS FF-B-588.

2.3.5 Wood Screws

ANSI B18.6.1.

2.3.6 Wire Nails

ASTM F 1667.

PART 3 EXECUTION

3.1 INSTALLATION

Fit framing and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Provide lumber and plywood as necessary for the proper completion of the work.

3.2 LUMBER

Provide sizes and configurations indicated or specified and anchored securely to substrate construction. Provide in lengths as long as possible and stagger joints when building up blocking.

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## SECTION 06410A

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11/01

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## SECTION 06410A

## ARCHITECTURAL CASEWORK

**11/01**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |             |  |
|-------------|--|
| ANSI A161.2 | (1998) Decorative Laminate Countertops,<br>Performance Standards for Fabricated High<br>Pressure |
| ANSI A208.1 | (1999) Particleboard Mat Formed Woods  |
| ANSI A208.2 | (1994) Medium Density Fiberboard (MDF)   |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |  |
|-------------|--|
| ASTM D 1037 | (1999) Evaluating Properties of Wood-Base<br>Fiber and Particle Panel Materials                        |
| ASTM F 547  | (1977; R 1995) Definitions of Terms<br>Relating to Nails for Use with Wood and<br>Wood-Based Materials |

## ARCHITECTURAL WOODWORK INSTITUTE (AWI)

- |               |  |
|---------------|--|
| AWI Qual Stds | (1999) Architectural Woodwork Quality<br>Standards |
|---------------|--|

## BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

- |             |                         |
|-------------|-------------------------|
| BHMA A156.9 | (1994) Cabinet Hardware |
|-------------|-------------------------|

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- |             |  |
|-------------|--|
| NEMA LD 3   | (1995) High-Pressure Decorative Laminates  |
| NEMA LD 3.1 | (1995) Performance, Application,<br>Fabrication, and Installation of<br>High-Pressure Decorative Laminates |

## WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

- |               |                                       |
|---------------|---------------------------------------|
| WDMA I.S. 1-A | (1997) Architectural Wood Flush Doors |
|---------------|---------------------------------------|

## 1.2 GENERAL DESCRIPTION

Work in this section includes wood and laminate clad custom casework

cabinets and countertops as shown on the drawings and as described in this specification. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Wood finish may be shop finished or field applied in accordance with Section 09900 PAINTING, GENERAL.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. All items designated with a "G", including product literature, calculations, component data, certificates, diagrams, drawings, and samples shall be submitted concurrently in one complete system submittal. Omission of any required submittal item from the package shall be sufficient cause for disapproval of the entire submittal. Unless otherwise indicated in the submittal review commentary, disapproval of any item within the package shall require a re-submittal of the entire system package, in which all deficiencies shall be corrected. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES.

#### SD-02 Shop Drawings

##### Shop Drawings Installation

Shop drawings showing all fabricated casework items in plan view, elevations and cross-sections to accurately indicate materials used, details of construction, dimensions, methods of fastening and erection, and installation methods proposed. Shop drawing casework items shall be clearly cross-referenced to casework items located on the project drawings. Shop drawings shall include a color schedule of all casework items to include all countertop, exposed, and semi-exposed cabinet finishes to include finish material manufacturer, pattern, and color.

#### SD-03 Product Data

##### Cabinet Hardware Wood Materials Wood Finishes

Descriptive data which provides narrative written verification of all types of construction materials and finishes, methods of construction, etc. not clearly illustrated on the submitted shop drawings. Data shall provide written verification of conformance with AWI Qual Stds for the quality indicated to include materials, tolerances, and types of construction. Both the manufacturer of materials and the fabricator shall submit available literature which describes re-cycled product content, operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

#### SD-04 Samples

#### Plastic Laminates

Two samples of each plastic laminate pattern and color. Samples shall be a minimum of 5 by 7 inches in size.

#### Cabinet Hardware

One sample of each cabinet hardware item specified to include hinges, pulls, drawer glides, and adjustable shelf support system.

#### SD-07 Certificates

##### Quality Assurance

##### Laminate Clad Casework

A quality control statement which illustrates compliance with and understanding of AWI Qual Stds requirements, in general, and the specific AWI Qual Stds requirements provided in this specification. The quality control statement shall also certify a minimum of ten years contractor's experience in laminate clad casework fabrication and construction. The quality control statement shall provide a list of a minimum of five successfully completed projects of a similar scope, size, and complexity.

#### 1.4 QUALITY ASSURANCE

Unless otherwise noted on the drawings, all materials, construction methods, and fabrication shall conform to and comply with the custom grade quality standards as outlined in AWI Qual Stds, Section 400 and the respective sub-sections for wood cabinets, laminate clad cabinets, and countertops. These standards shall apply in lieu of omissions or specific requirements in this specification. Contractors and their personnel engaged in the work shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified. Contractor must demonstrate knowledge and understanding of AWI Qual Stds requirements for the quality grade indicated.

#### 1.5 DELIVERY AND STORAGE

Casework may be delivered knockdown or fully assembled. All units shall be delivered to the site in undamaged condition, stored off the ground in fully enclosed areas, and protected from damage. The storage area shall be well ventilated and not subject to extreme changes in temperature or humidity.

#### 1.6 SEQUENCING AND SCHEDULING

Work shall be coordinated with other trades. Units shall not be installed in any room or space until painting, and ceiling installation are complete within the room where the units are located. Floor cabinets shall be installed before finished flooring materials are installed.

#### 1.7 PROJECT/SITE CONDITIONS

Field measurements shall be verified as indicated in the shop drawings before fabrication.

## PART 2 PRODUCTS

### 2.1 WOOD MATERIALS

#### 2.1.1 Lumber

All framing lumber shall be kiln-dried Grade III to dimensions as shown on the drawings. Frame front, where indicated on the drawings, shall be nominal 3/4 inch hardwood.

##### 2.1.1.1 Solid Wood

Solid wood casework components which are indicated to receive a transparent finish shall be Select Red Birch hardwood species, plain sawn. AWI grade shall be custom. Location, shape, and dimensions shall be as indicated on the drawings.

#### 2.1.2 Panel Products

##### 2.1.2.1 Plywood

All plywood panels used for framing purposes shall be veneer core hardwood plywood, AWI Qual Stds Grade AA. Nominal thickness of plywood panels shall be as indicated in this specification and on the drawings. Wood veneer shall be Select Red Birch.

##### 2.1.2.2 Particleboard

All particleboard shall be industrial grade, medium density (40 to 50 pounds per cubic foot), 3/4 inch thick. A moisture-resistant particleboard in grade Type 2-M-2 or 2-M-3 shall be used as the substrate for plastic laminate covered countertops with sinks and other areas subjected to moisture. Particleboard shall meet the minimum standards listed in ASTM D 1037 and ANSI A208.1.

##### 2.1.2.3 Medium Density Fiberboard

Medium density fiberboard (MDF) shall be an acceptable panel substrate except for countertops. Medium density fiberboard shall meet the minimum standards listed in ANSI A208.2.

### 2.2 HIGH PRESSURE DECORATIVE LAMINATE (HPDL)

All plastic laminates shall meet the requirements of NEMA LD 3 and ANSI A161.2 for high-pressure decorative laminates. Design, colors, surface finish and texture, and locations shall be as indicated on the drawings. Plastic laminate types and nominal minimum thicknesses for casework components shall be as indicated in the following paragraphs.

#### 2.2.1 Horizontal General Purpose Standard (HGS) Grade

Horizontal general purpose standard grade plastic laminate shall be 0.048 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where postforming is not required.

#### 2.2.2 Vertical General Purpose Standard (VGS) Grade

Vertical general purpose standard grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is



intended for exposed exterior vertical surfaces of casework components where postforming is not required.

#### 2.2.3 Horizontal General Purpose Postformable (HGP) Grade

Horizontal general purpose postformable grade plastic laminate shall be 0.042 inches (plus or minus 0.005 inches) in thickness. This laminate grade is intended for horizontal surfaces where post forming is required.

#### 2.2.4 Vertical General Purpose Postformable (VGP) Grade

Vertical general purpose postformable grade plastic laminate shall be 0.028 inches (plus or minus 0.004 inches) in thickness. This laminate grade is intended for exposed exterior vertical surfaces of components where postforming is required for curved surfaces.

#### 2.2.5 Cabinet Liner Standard (CLS) Grade

Cabinet liner standard grade plastic laminate shall be 0.020 inches in thickness. This laminate grade is intended for light duty semi-exposed interior surfaces of casework components.

#### 2.2.6 Backing Sheet (BK) Grade

Undecorated backing sheet grade laminate is formulated specifically to be used on the backside of plastic laminated panel substrates to enhance dimensional stability of the substrate. Backing sheet thickness shall be 0.020 inches. Backing sheets shall be provided for all laminated casework components where plastic laminate finish is applied to only one surface of the component substrate.

#### 2.3 THERMOSET DECORATIVE OVERLAYS (MELAMINE)

Thermoset decorative overlays (melamine panels) shall be used for casework cabinet interior and drawer interior surfaces.

#### 2.4 EDGE BANDING

Edge banding for casework doors and drawer fronts may be PVC vinyl in lieu of plastic laminate and shall be 0.020 inch thick. Material width shall match edge condition. Color and pattern shall match exposed door and drawer front laminate pattern and color.

#### 2.5 CABINET HARDWARE

All hardware shall conform to BHMA A156.9, unless otherwise noted, and shall consist of the following components:

a. Door Hinges: BHMA No. B01602 frameless concealed hinges at wall and base cabinet doors and BHMA No. B01351 butt hinges at tall cabinets. Butt hinges shall be 3 1/2 inches high. Provide three per door leaf.

b. Cabinet Pulls: Wire type, BHMA No. B42011, 4-inch center to center, 1 15/16-inch projection.

c. Drawer Slide: Side mounted self-closing type, BHMA No. B05091 with full extension and a minimum 75 pound load capacity. Slides shall include an integral positive stop to avoid accidental drawer removal.

d. Adjustable Shelf Support System:

1) Recessed (mortised) metal standards for end supported shelves, BHMA No. B04071, finish: 626. Support clips for the standards shall be either open type, BHMA No. B04091 or closed type, BHMA No. B04081, finish: 626.

2) Vertical slotted metal standards for center supported shelves, BHMA No. B04102, Finish 626. Shelf brackets for vertical slotted standards shall be BHMA No. B04112, Finish 626.

e. Door Locks: BHMA E07111 at tall cabinet doors.

2.6 FASTENERS

Nails, screws, and other suitable fasteners shall be the size and type best suited for the purpose and shall conform to ASTM F 547 where applicable.

2.7 ADHESIVES, CAULKS, AND SEALANTS

2.7.1 Adhesives

Adhesives shall be of a formula and type recommended by AWI. Adhesives shall be selected for their ability to provide a durable, permanent bond and shall take into consideration such factors as materials to be bonded, expansion and contraction, bond strength, fire rating, and moisture resistance. Adhesives shall meet local regulations regarding VOC emissions and off-gassing.

2.7.1.1 Wood Joinery

Adhesives used to bond wood members shall be a Type II for interior use urea-formaldehyde resin formula or polyvinyl acetate resin emulsion. Adhesives shall withstand a bond test as described in WDMA I.S. 1-A.

2.7.1.2 Laminate Adhesive

Adhesive used to join high-pressure decorative laminate to wood shall be an adhesive consistent with AWI and laminate manufacturer's recommendations. PVC edgbanding shall be adhered using a polymer-based hot melt glue.

2.7.2 Caulk

Caulk used to fill voids and joints between laminated components and between laminated components and adjacent surfaces shall be clear, 100 percent silicone.

2.7.3 Sealant

Sealant shall be of a type and composition recommended by the substrate manufacturer to provide a moisture barrier at sink cutouts and all other locations where unfinished substrate edges may be subjected to moisture.

2.8 WOOD FINISHES

Stain, varnish and their applications required for exposed wood casework components shall be as indicated in Section 09900 PAINTING, GENERAL. Location shall be as indicated on the drawings.

## 2.9 ACCESSORIES

### 2.9.1 Glass and Glazing

Glass required in wood casework shall be fully tempered clear glass in accordance with Section 08810A GLASS AND GLAZING. Thickness shall be 1/2-inch for shelving and 1/4-inch for doors.

## 2.10 FABRICATION

Fabrication and assembly of components shall be accomplished at the shop site to the maximum extent possible. Construction and fabrication of cabinets and their components shall meet or exceed the requirements for AWI custom grade unless otherwise indicated in this specification. Cabinet style, in accordance with AWI Qual Stds, Section 400-G descriptions, shall be reveal overlay for wall and base cabinets and as indicated on the drawings for tall cabinets.

### 2.10.1 Cabinet Case Body

Frame members shall be glued-together, kiln-dried hardwood lumber. Top corners, bottom corners, and cabinet bottoms shall be braced with either hardwood blocks or water-resistant glue and nailed in place metal or plastic corner braces. Cabinet components shall be constructed from the following materials and thicknesses:

- a. Body Members (Ends, Divisions, Bottoms, and Tops): 3/4 inch particleboard, medium density fiberboard (MDF) or veneer core plywood panel product.
- b. Face Frames and Rails: 3/4 inch hardwood lumber.
- c. Shelving: 3/4 inch particleboard, medium density fiberboard (MDF) or veneer core plywood.
- d. Cabinet Backs: 1/4 inch particleboard, medium density fiberboard 9MDF or veneer core plywood.
- e. Drawer Sides, Backs, and Subfronts: 1/2 inch thermoset decorative overlay panel product.
- f. Drawer Bottoms: 1/4 inch thermoset decorative overlay panel product.
- g. Door and Drawer Fronts: 3/4-inch particleboard or medium density fiberboard (MDF) panel product.

#### 2.10.1.1 Joinery Method for Case Body Members

- a. Tops, Exposed Ends, and Bottoms.
  - 1) Steel "European" assembly screws (1-1/2 inch from end, 5 inch on center, fasteners will not be visible on exposed parts).
  - 2) Doweled, glued under pressure (approx. 4 dowels per 12 inches of joint).
  - 3) Stop dado, glued under pressure, and either nailed, stapled or screwed (fasteners will not be visible on exposed parts).

4) Spline or biscuit, glued under pressure.

b. Exposed End Corner and Face Frame Attachment.

1) For mitered joint: lock miter or spline or biscuit, glued under pressure (no visible fasteners).

2) For non-mitered joint (90 degree): butt joint glued under pressure (no visible fasteners).

3) Butt joint, glued and nailed.

c. Cabinet Backs (Wall Hung Cabinets): Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transfer the load to case body members. Fabrication method shall be:

1) Full bound, captured in grooves on cabinet sides, top, and bottom. Cabinet backs for floor standing cabinets shall be side bound, captured in grooves; glued and fastened to top and bottom.

2) Full overlay, plant-on backs with minimum back thickness of 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

3) Side bound, captured in groove or rabbetts; glued and fastened.

d. Cabinet Backs (Floor Standing Cabinets).

1) Side bound, captured in grooves; glued and fastened to top and bottom.

2) Full overlay, plant-on backs with minimum back thickness of 1/2 inch and minimum No. 12 plated (no case hardened) screws spaced a minimum 3 inches on center. Edge of back shall not be exposed on finished sides. Anchor strips are not required when so attached.

3) Side bound, placed in rabbetts; glued and fastened in rabbetts.

e. Wall Anchor Strips shall be required for all cabinets with backs less than 1/2 inch thick. Strips shall consist of minimum 1/2 inch thick lumber, minimum 2-1/2 inches width; securely attached to wall side of cabinet back - top and bottom for wall hung cabinets, top only for floor standing cabinets.

2.10.2 Cabinet Floor Base

Floor cabinets shall be mounted on a base constructed of 3/4 inch particleboard, 3/4 inch fiberboard or 3/4 inch veneer core exterior plywood. Finished height for each cabinet base shall be not less than the full height of the installed, specified wall base.

2.10.3 Cabinet Door and Drawer Fronts

Door and drawer fronts shall be fabricated from 3/4 inch medium density particleboard or 3/4 inch medium density fiberboard (MDF). All door and

drawer front edges shall be surfaced with high pressure plastic laminate or PVC edgebanding, color and pattern to match exterior face laminate.

#### 2.10.4 Drawer Assembly

Drawer components shall consist of a removable drawer front, sides, backs, and bottom. Drawer components shall be constructed of the following materials and thicknesses:

- a. Drawer Sides and Back For Thermoset Decorative Overlay (melamine) Finish: 1/2 inch thick medium density particleboard or MDF fiberboard substrate.
- b. Drawer Bottom: 1/4 inch thick thermoset decorative overlay melamine panel product.

##### 2.10.4.1 Drawer Assembly Joinery Method

- a. Multiple dovetail (all corners) or French dovetail front/dadoed back, glued under pressure.
- b. Doweled, glued under pressure.
- c. Lock shoulder, glued and pin nailed.
- d. Bottoms shall be set into sides, front, and back, 1/4 inch deep groove with a minimum 3/8 inch standing shoulder.

#### 2.10.5 Shelving

Shelving shall be fabricated from 3/4 inch medium density particleboard, 3/4 inch medium density fiberboard (MDF) or 3/4 inch veneer core plywood. All shelving top and bottom surfaces shall be finished with HPDL plastic laminate. Shelf edges shall be finished in a HPDL plastic laminate or PVC edgebanding.

##### 2.10.5.1 Shelf Support System

The shelf support system shall be:

- a. Recessed (mortised) metal shelf standards. Standards shall be mortised flush with the finishes surface of the cabinet interior side walls, two per side. Standards shall be positioned and spaced on the side walls to provide a stable shelf surface that eliminates tipping when shelf front is weighted. Standards shall be installed and adjusted vertically to provide a level, stable shelf surface when clips are in place.

#### 2.10.6 Laminate Clad Countertops

Laminate countertop substrate shall be constructed of 3/4 inch particleboard or medium density fiberboard (MDF). The substrate shall be moisture-resistant where countertops receive sinks, lavatories, or are subjected to liquids. All substrates shall have sink cutout edges sealed with appropriate sealant against moisture. No joints shall occur at any cutouts. A balanced backer sheet is required.

#### 2.10.6.1 Edge Style

Front and exposed side countertop edges shall be in shapes and to dimensions as shown on the drawings. The countertop edge material shall be:

- a. Post formed plastic laminate. Laminate edge shall be integral with countertop surface. Shape and profile shall be as indicated on the drawings and to dimensions as indicated on the drawings.

#### 2.10.6.2 Laminate Clad Splashes

Countertop splash substrate shall be 3/4 inch particleboard or MDF fiberboard. Laminate clad backsplash shall be loose, to be installed at the time of countertop installation. Side splashes shall be straight profile and provided loose, to be installed at the time of countertop installation. Back and side splash laminate pattern and color shall match the adjacent countertop laminate.

#### 2.10.7 Laminate Application

Laminate application to substrates shall follow the recommended procedures and instructions of the laminate manufacturer and NEMA LD 3.1, using tools and devices specifically designed for laminate fabrication and application.

Provide a balanced backer sheet (Grade BK) wherever only one surface of the component substrate requires a plastic laminate finish. Apply required grade of laminate in full uninterrupted sheets consistent with manufactured sizes using one piece for full length only, using adhesives specified herein or as recommended by the manufacturer. Fit corners and joints hairline. All laminate edges shall be machined flush, filed, sanded, or buffed to remove machine marks and eased (sharp corners removed). Clean up at easing shall be such that no overlap of the member eased is visible. Fabrication shall conform to NEMA LD 3.1 and ANSI A161.2. Laminate types and grades for component surfaces shall be as follows unless otherwise indicated on the drawings:

- a. Base/Wall Cabinet Case Body.

- 1) Exterior (exposed) surfaces to include exposed and semi-exposed face frame surfaces: HPDL Grade VGS.
- 2) Interior (semi-exposed) surfaces to include interior back wall, bottom, and side walls: HPDL Grade CLS.

- b. Adjustable Shelving.

- 1) Top and bottom surfaces: HPDL Grade HGS.
- 2) All edges: HPDL Grade VGS or PVC edgebanding.

- c. Fixed Shelving.

- 1) Top and bottom surfaces: HPDL Grade HGS.
- 2) Exposed edges: HPDL Grade VGS or PVC edgebanding.

- d. Door, Drawer Fronts, Access Panels.

- 1) Exterior (exposed) and interior (semi-exposed) faces: HPDL Grade VGS.

2) Edges: HPDL Grade VGS or PVC edgebanding.

e. Drawer Assembly.

All interior and exterior surfaces: Thermoset Decorative Overlay (melamine).

f. Countertops and Splashes.

1) All exposed surfaces: HPDL Grade HGS (HGP where post formed).

2) Concealed surfaces: HPDL Grade BKL.

2.10.7.1 Tolerances

Flushness, flatness, and joint tolerances of laminated surfaces shall meet the AWI Qual Stds custom grade requirements.

2.10.8 Finishing

2.10.8.1 Filling

No fasteners shall be exposed on laminated surfaces. All nails, screws, and other fasteners in non-laminated cabinet components shall be countersunk and the holes filled with wood filler consistent in color with the wood species.

2.10.8.2 Sanding

All surfaces requiring coatings shall be prepared by sanding with a grit and in a manner that scratches will not show in the final system.

2.10.8.3 Coatings

Types and method of application and location of wood casework finishes shall be in accordance with the finish schedule, drawings and Section 09900 PAINTING, GENERAL.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall comply with applicable requirements for AWI Qual Stds custom quality standards. Countertops and fabricated assemblies shall be installed level, plumb, and true to line, in locations shown on the drawings. Cabinets and other laminate clad casework assemblies shall be attached and anchored securely to the floor and walls with mechanical fasteners that are appropriate for the wall and floor construction.

3.1.1 Anchoring Systems

3.1.1.1 Floor

Cabinets shall utilize a floor anchoring system. Anchoring and mechanical fasteners shall not be visible from the finished side of the casework assembly. Cabinet assemblies shall be attached to anchored bases without visible fasteners. Where assembly abutts a wall surface, anchoring shall include a minimum 1/2 inch thick lumber or panel product hanging strip,

minimum 2-1/2 inch width; securely attached to the top of the wall side of the cabinet back.

#### 3.1.1.2 Wall

Cabinets and vanities to be wall mounted shall utilize minimum 1/2 inch thick lumber or panel product hanging strips, minimum 2-1/2 inch width; securely attached to the wall side of the cabinet back, both top and bottom.

#### 3.1.2 Countertops

Countertops shall be installed in locations as indicated on the drawings. Countertops shall be fastened to supporting casework structure with mechanical fasteners, hidden from view. All joints formed by the countertop or countertop splash and adjacent wall surfaces shall be filled with a silicone caulk to match color of plastic laminate.

##### 3.1.2.1 Loose Splashes

Loose back and side splashes shall be adhered to both the countertop surface perimeter and the adjacent wall surface with adhesives appropriate for the type of materials to be adhered. Joints between the countertop surface and splash shall be filled with silicone caulk in a smooth consistent concave bead. Bead size shall be the minimum necessary to fill the joint and any surrounding voids or cracks. Color shall match color of plastic laminate.

#### 3.1.3 Hardware

Casework hardware shall be installed in types and locations as indicated on the drawings. Where fully concealed European-style hinges are specified to be used with particleboard or fiberboard doors, the use of plastic or synthetic insertion dowels shall be used to receive 3/16 inch "Euroscrews". The use of wood screws without insertion dowels is prohibited.

#### 3.1.4 Doors, Drawers and Removable Panels

The fitting of doors, drawers and removable panels shall be accomplished within target fitting tolerances for gaps and flushness in accordance with AWI Qual Stds custom grade requirements.

#### 3.1.5 Plumbing Fixtures

Sinks, sink hardware, and other plumbing fixtures shall be installed in locations as indicated on the drawings and in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

#### 3.1.6 Glass

Glass and glazing shall be installed in the casework using methods and materials specified in Section 08810A GLASS AND GLAZING in locations as indicated on the drawings.

-- End of Section --



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## DIVISION 06 - WOOD AND PLASTICS

## SECTION 06650

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10/00

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## SECTION 06650

SOLID POLYMER (SOLID SURFACING) FABRICATIONS  
10/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |             |  |
|-------------|--|
| ANSI A108.1 | (1999) Installation of Ceramic Tile;<br>including A108.1A-C, 108.4-.13, 118.1-.10,<br>A136.1 |
| ANSI Z124.3 | (1995) Plastic Lavatories  |
| ANSI Z124.6 | (1997) Plastic Sinks   |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |  |
|-------------|--|
| ASTM D 570  | (1998) Water Absorption of Plastics  |
| ASTM D 638  | (1999) Tensile Properties of Plastics  |
| ASTM D 696  | (1998) Coefficient of Linear Thermal<br>Expansion of Plastics Between Minus 30<br>degrees C and 30 degrees C |
| ASTM D 2583 | (1995) Indentation Hardness of Rigid<br>Plastics by Means of a Barcol Impressor                              |
| ASTM E 84   | (1999) Surface Burning Characteristics of<br>Building Materials  |
| ASTM G 21   | (1996) Determining Resistance of Synthetic<br>Polymeric Materials to Fungi                                   |
| ASTM G 22   | (1976; R 1996) Determining Resistance of<br>Plastics to Bacteria   |

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- |           |   |
|-----------|---|
| NEMA LD 3 | (1995) High Pressure Decorative Laminates |
|-----------|---|

## 1.2 GENERAL DESCRIPTION

Work in this section includes vanity tops, window sills, and other items utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Shop Drawings  
Installation

Shop Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work.

#### SD-03 Product Data

Solid polymer material  
Qualifications  
Fabrications

Product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer, joint adhesive, and sealants. Both the manufacturer of materials and the fabricator shall submit a detailed description of operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

#### SD-04 Samples

Material

A minimum 4 by 4 inch sample of each color and pattern for approval. Samples shall indicate full range of color and pattern variation. Approved samples shall be retained as a standard for this work.

#### SD-06 Test Reports

Solid polymer material

Test report results from an independent testing laboratory attesting that the submitted solid polymer material meets or exceeds each of the specified performance requirements.

#### SD-07 Certificates

Fabrications  
Qualifications

Solid polymer manufacturer's certification attesting to fabricator qualification approval.

#### SD-10 Operation and Maintenance Data

Solid polymer material  
Clean-up

A minimum of six copies of maintenance data indicating manufacturer's care, repair and cleaning instructions. Maintenance video shall be provided, if available. Maintenance kit for matte finishes shall be submitted.

#### 1.4 DELIVERY, STORAGE AND HANDLING

Materials shall not be delivered to project site until areas are ready for installation. Materials shall be stored indoors and adequate precautions taken to prevent damage to finished surfaces. Protective coverings shall be provided to prevent physical damage or staining following installation, for duration of project.

#### 1.5 WARRANTY

Manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat, shall be provided. Warranty shall provide for material and labor for replacement or repair of defective material for a period of ten years after component installation.

#### 1.6 QUALIFICATIONS

To insure warranty coverage, solid polymer fabricators shall be certified to fabricate by the solid polymer material manufacturer being utilized. All fabrications shall be marked with the fabricator's certification label affixed in an inconspicuous location. Fabricators shall have a minimum of 5 years of experience working with solid polymer materials.

### PART 2 PRODUCTS

#### 2.1 MATERIAL

Solid polymer material shall be a homogeneous filled solid polymer; not coated, laminated or of a composite construction; meeting ANSI Z124.3 and ANSI Z124.6 requirements. Material shall have minimum physical and performance properties specified. Superficial damage to a depth of 0.01 inch shall be repairable by sanding or polishing. Material thickness shall be as indicated on the drawings. If not indicated, material shall not be less than 3/4 inch in thickness.

##### 2.1.1 Cast, 100 Percent Acrylic Polymer Solid Surfacing Material

Cast, 100 percent acrylic solid polymer material shall be composed of acrylic polymer, mineral fillers, and pigments and shall meet the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	5800 psi (min.)	ASTM D 638
Hardness	55-Barcol Impressor (min.)	ASTM D 2583

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Thermal Expansion	.000023 in/in/F (max.)	ASTM D 696
Boiling water Surface Resistance	No Change	NEMA LD 3-3.05
High Temperature Resistance	No Change	NEMA LD 3-3.06
Impact Resistance (Ball drop)		NEMA LD 3-303
1/4" sheet	36", 1/2 lb ball, no failure	
1/2" sheet	140", 1/2 lb ball, no failure	
3/4" sheet	200", 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G 21
Bacteria Growth	No Growth	ASTM G 22
Liquid Absorption (Weight in 24 hrs.)	0.1% max.	ASTM D 570
Flammability		ASTM E 84
Flame Spread	25 max.	
Smoke Developed	30 max	

#### 2.1.2 Material Patterns and Colors

Patterns and colors for all solid polymer components and fabrications shall be those indicated on the project drawings. Pattern and color shall occur, and shall be consistent in appearance, throughout the entire depth (thickness) of the solid polymer material.

#### 2.1.3 Surface Finish

Exposed finished surfaces and edges shall receive a uniform appearance. Exposed surface finish shall be matte; gloss rating of 5-20.

### 2.2 ACCESSORY PRODUCTS

Accessory products, as specified below, shall be manufactured by the solid polymer manufacturer or shall be products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.

#### 2.2.1 Seam Adhesive

Seam adhesive shall be a two-part adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between

solid polymer materials and components to create a monolithic appearance of the fabrication. Adhesive shall be approved by the solid polymer manufacturer. Adhesive shall be color-matched to the surfaces being bonded where solid-colored, solid polymer materials are being bonded together. The seam adhesive shall be clear or color matched where particulate patterned, solid polymer materials are being bonded together.

#### 2.2.2 Panel Adhesive

Panel adhesive shall be neoprene based panel adhesive meeting ANSI A108.1, Underwriter's Laboratories (UL) listed. This adhesive shall be used to bond solid polymer components to adjacent and underlying substrates.

#### 2.2.3 Silicone Sealant

Sealant shall be a mildew-resistant, FDA and UL listed silicone sealant. Color shall match solid polymer. The silicone sealant shall be approved for use by the solid polymer manufacturer. Sealant shall be used to seal all joints between solid polymer components and other adjacent surfaces such as walls and plumbing fixtures.

### 2.3 FABRICATIONS

Components shall be factory or shop fabricated to the greatest extent practical to sizes and shapes indicated, in accordance with approved Shop Drawings and manufacturer's requirements. Factory cutouts shall be provided for lavatories and plumbing fixtures where indicated on the drawings. Contours and radii shall be routed to template, with edges smooth. Defective and inaccurate work will be rejected.

#### 2.3.1 Joints and Seams

Joints and seams shall be formed between solid polymer components using manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.

#### 2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish. Edge shapes and treatments, including any inserts, shall be as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

#### 2.3.3 Vanity Top Splashes

Backsplashes and end splashes shall be fabricated from 1/2 inch thick solid surfacing material and shall be 4 inches high. Backsplashes and end splashes shall be provided for all vanity tops. Backsplashes and end splashes shall be delivered loose, to be field attached.

#### 2.3.4 Window Sills

Window sills shall be fabricated from 3/4 inch thick solid surfacing, solid polymer material. Dimensions, edge shape, and other details shall be as indicated on the drawings.

#### 2.3.5 Vanity Tops

Vanity tops shall be fabricated from 3/4 inch thick solid surfacing

material. Edge details, dimensions and locations shall be as indicated on the Drawings. Attach 2 inch wide reinforcing strip of polymer material under each horizontal vanity top seam.

#### 2.3.5.1 Vanity Tops With Bowls

##### A. Vitreous China Bowl

Vanity tops indicated to receive vitreous china bowls shall include cutouts to template as furnished by the sink manufacturer. Seam between sink rim and counter top shall be sealed with silicone sealant of a color to match solid surfacing material. Sink, faucet, and plumbing requirements shall be in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

### PART 3 EXECUTION

#### 3.1 COORDINATION

In most instances, installation of solid polymer fabricated components and assemblies will require strong, correctly located structural support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid polymer fabricator/installer and other trades to insure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of vanity tops, window sills, and all other solid polymer fabrications to the degree and extent recommended by the solid polymer manufacturer. Contractor shall appropriate staging areas for solid polymer fabrications.

#### 3.2 INSTALLATION

##### 3.2.1 Components

All components and fabricated units shall be installed plumb, level, and rigid. Field joints between solid polymer components to provide a monolithic appearance shall be made using solid polymer manufacturer's approved seam adhesives, with joints inconspicuous in the finished work.

##### 3.2.1.1 Loose Vanity Top Splashes

Loose splashes shall be mounted in locations as noted on the drawings. Loose splashes shall be adhered to the counter top with a color matched silicone sealant when the solid polymer components are solid colors. Adhesion of particulate patterned solid polymer splashes to counter tops shall utilize a clear silicone sealant.

##### 3.2.2 Silicone Sealant

A silicone sealant or caulk shall be used to seal all joints between solid polymer components and other adjacent surfaces such as walls, and plumbing fixtures. Sealant bead shall be smooth and uniform in appearance and shall be the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Bead shall be continuous and run the entire length of the joint being sealed. Color shall match the solid surfacing material.

### 3.2.3 Plumbing

Plumbing connections to lavatories shall be made in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

### 3.3 CLEAN-UP

Components shall be cleaned after installation and covered to protect against damage during completion of the remaining project items. Components damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who shall approve estimate before repairs are made.

-- End of Section --



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SECTION 07110A

BITUMINOUS DAMPPROOFING

09/98

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## SECTION 07110A

BITUMINOUS DAMPPROOFING  
09/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 1187	(1997) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D 1227	(1995) Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D 4479	(1993) Asphalt Roof Coatings - Asbestos Free

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-07 Certificates

## Dampproofing Materials

Certificates attesting that the materials meet the requirements specified.

## 1.3 QUALIFICATIONS

Work shall be performed by skilled laborers thoroughly experienced in the type of bituminous dampproofing work specified to meet the requirements of the contract.

## 1.4 DELIVERY, STORAGE AND HANDLING

Dampproofing materials shall be delivered to the project site in the original sealed containers bearing the name of manufacturer, contents and brand name, and stored in a weathertight enclosure to prevent moisture damage and absorption. Dampproofing materials shall be protected from freezing. Asphalt shall be stored off the ground on pallets, and covered

on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup; and therefore, shall not be used to cover dampproofing materials. Care shall be taken during storage to avoid separation or settlement of the emulsion components. Damaged or deteriorated materials shall be removed from the project site.

## PART 2 PRODUCTS

Contractor shall have the option of using either emulsion-based or solvent-based dampproofing.

### 2.1 EMULSION-BASED ASPHALT DAMPPROOFING

#### 2.1.1 Fibrated Emulsion-Based Asphalt

Fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1227 Type IV, asbestos-free, manufactured of refined asphalt, emulsifiers and selected clay, fibrated with mineral fibers. For spray or brush application, emulsion shall contain a minimum of 59 percent solids by weight, 56 percent solids by volume. For trowel application, emulsion shall contain a minimum of 58 percent solids by weight, 55 percent solids by volume.

#### 2.1.2 Non-Fibrated Emulsion-Based Asphalt

Non-fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1187 Type II or ASTM D 1227 Type III, manufactured of refined asphalt, emulsifiers and selected clay. Asphalt shall contain a minimum 58 percent solids by weight, 55 percent solids by volume.

### 2.2 SOLVENT-BASED ASPHALT DAMPPROOFING

#### 2.2.1 Asphaltic Primer

Primer for cold-applied solvent-based asphalt dampproofing shall conform to ASTM D 41, asbestos-free, non-fibrated, manufactured with highly ductile soft asphalts and selected hydrocarbons.

#### 2.2.2 Fibrated Asphalt

Fibrated solvent-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 4479 Type I, asbestos-free, manufactured with selected asphalts, stabilizers, mineral spirits and fibrated with mineral fibers. Solvent-based asphalt shall contain 72 percent solids by weight, 65 percent solids by volume.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces scheduled for bituminous dampproofing shall be prepared in accordance with dampproofing manufacturer's recommendations. Surface preparation shall be approved prior to dampproofing application.

#### 3.1.1 Protection of Surrounding Areas

Before starting the dampproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of asphalt onto other work. Drains and conductors shall be protected from clogging with asphalt.

### 3.1.2 Masonry Surfaces

Surfaces shall be free of oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Mortar joints shall be flush and free of extraneous mortar and chipped or broken masonry.

### 3.2 APPLICATION OF BITUMINOUS DAMPPROOFING

Dampproofing shall be applied to the cavity face of the CMU wythe of all CMU/brick veneer cavity-wall construction and where indicated elsewhere.

#### 3.2.1 Emulsion-Based Asphalt

Emulsion-based asphalt dampproofing work shall not be performed in temperatures below 40 degrees F. Emulsions shall have a smooth and uniform consistency at time of application. Dampproofing materials shall be applied in accordance with manufacturer's published instructions to produce a smooth uniform dry film of not less than 12 mils thick without voids or defects. Dull or porous spots shall be recoated. Dampproofing materials shall seal tightly around pipes and other items projecting through dampproofing. Rates of application shall be as follows:

- a. Primer: 1/2 gallon per 100 square feet, cold-applied.
- b. Fibrated Dampproofing: 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.
- c. Non-fibrated Dampproofing: 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

#### 3.2.2 Solvent-Based Asphalt

Solvent-based asphalt dampproofing work shall not be performed in temperatures below 40 degrees F. Dampproofing materials shall be applied in accordance with manufacturer's published instructions to produce a smooth uniform dry film not less than 12 mils thick without voids or defects. Dull or porous spots shall be recoated. Dampproofing materials shall seal tightly around pipes and other items projecting through dampproofing. Rates of application shall be as follows:

- a. Primer: 1/2 gallon per 200 square feet, cold-applied.
- b. Dampproofing Coat: 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

### 3.3 CLEAN-UP

Surfaces of other work which are stained with dampproofing materials shall be cleaned with a cleaner recommended by dampproofing manufacturer.

### 3.4 PROTECTION

The completed dampproofing work shall be protected from damage during and after construction.

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SECTION 07131

ELASTOMERIC SHEET WATERPROOFING

03/02

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## SECTION 07131

ELASTOMERIC SHEET WATERPROOFING  
03/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1149	(1991; R 1999) Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D 146	(1997) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D 2240	(2000) Rubber Property - Durometer Hardness
ASTM D 297	(1993; R 1998) Rubber Products - Chemical Analysis
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 412	(1998a) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	(1998e1) Rubber Property - Effect of Liquids
ASTM D 5385	(1993) Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes E1-2000 R(2000)
ASTM D 570	(1998) Water Absorption of Plastics
ASTM D 573	(1988; R 1999) Rubber - Deterioration in an Air Oven
ASTM D 624	(2000) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 746	(1998) Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 903	(1998) Standard Test Method for Peel or

## Stripping Strength of Adhesive Bonds

ASTM E 154 (1988; R 1999) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

ASTM E 96 (2000) Water Vapor Transmission of Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Elastomeric waterproofing sheet material

Protection board

Primers, adhesives, and mastics

## SD-06 Test Reports

Elastomeric waterproofing sheet material

Certify compliance with performance requirements specified herein.

## SD-08 Manufacturer's Instructions

Submit Manufacturer's material safety data sheets for primers, adhesives and mastics.

## 1.3 QUALITY ASSURANCE

## 1.3.1 Shop Drawing Requirements

Include description and physical properties; termination details; application details; recommendations regarding shelf life, application procedures; requirements for protective covering; and precautions for flammability and toxicity.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver and store materials out of the weather, in manufacturer's original packaging with brand name and product identification clearly marked. Do not permit uncertified materials in the work area.

## 1.5 ENVIRONMENTAL CONDITIONS

Do not apply waterproofing during inclement weather or when there is ice, frost, surface moisture, or visible dampness on the surface to receive waterproofing and when ambient and surface temperatures are 40 degrees F or below. The restriction on the application of waterproofing materials when ambient and surface temperatures are below 40 degrees F will be waived if the Contractor devises a means, approved by the Contracting Officer, of

maintaining the surface and ambient temperatures above 40 degrees F.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Provide one of the types of elastomeric waterproofing sheet material and related primers, adhesives, and mastics as specified herein. Ensure compatibility of waterproofing materials within a specific type, with each other, and with the materials on which they will be applied. Materials shall conform to the applicable performance requirements cited below when tested in accordance with the referenced ASTM publications.

### 2.2 BUTYL RUBBER SHEETING

Not less than 60 mils minimum thickness.

#### 2.2.1 Butyl Rubber Sheeting Performance Requirements

- a. Thickness Tolerance, ASTM D 412: Plus or minus 10 percent;
- b. Specific Gravity, ASTM D 297: 1.20, plus or minus 0.05;
- c. Tensile Strength, ASTM D 412: 1200 psi minimum;
- d. Tensile Stress at 300 percent elongation, ASTM D 412: 600 psi minimum;
- e. Elongation, ASTM D 412: 300 percent minimum;
- f. Tear Resistance, Die C, ASTM D 624: 150 pound force per inch (lbf/inch) minimum;
- g. Shore A Hardness, ASTM D 2240: Five-second interval before reading; 60 plus or minus 10;
- h. Ozone Resistance, ASTM D 1149: No cracks, 7 days - 50 pphm - 100 degrees F, 20 percent elongation;
- i. Heating Aging-Accelerated, ASTM D 573: Tensile retention, 60 percent of minimum original elongation retention; 60 percent of minimum original requirement; 7 days, 240 degrees F;
- j. Butyl Identification, ASTM D 471, Tricresyl Phosphate Immersion: Maximum volume swell 10 percent, 70 hrs, 212 degrees F;
- k. Low Temperature Flexibility, ASTM D 746: No failure at -40 degrees F;
- l. Water Absorption, ASTM D 471: +1 percent maximum. 7 days, 158 degrees F;
- m. Exposure to Fungi and Bacteria in Soil, ASTM E 154, Minimum 16 Weeks: Unaffected; and
- n. Water Vapor Transmission, 80 Degrees F Permeance, ASTM E 96, Procedure B or BW: 0.15 perms maximum.



### 2.2.2 Adhesive, Cement, and Tape for Use with Butyl Rubber

As recommended by the butyl rubber waterproofing membrane manufacturer.

### 2.3 COMPOSITE, SELF-ADHERING MEMBRANE SHEETING

Cold applied composite sheet consisting of rubberized asphalt and cross laminated, high density polyethylene film. Not less than 60 mils minimum thickness is required.

#### 2.3.1 Composite, Self-Adhering Sheeting Performance Requirements

- a. Tensile Strength, ASTM D 412, Die C: 250 psi minimum;
- b. Ultimate Elongation, ASTM D 412, Die C: 200 percent minimum;
- c. Water Vapor Transmission, ASTM E 96 80 Degrees F Permeance, Procedure B: 0.1 perm maximum;
- d. Pliability Degrees F, ASTM D 146: (180 Degrees Bend Over One Inch Mandrel): No cracks at minus -25 degrees F;
- e. Cycling Over Crack at Minus 15 Degrees F: Membrane is applied and rolled across two primed concrete blocks with no separation between blocks. Crack opened and closed from zero to 1/4 inch. No effect at 100 cycles;
- f. Puncture Resistance, ASTM E 154: 40 lb. minimum;
- g. Lap Adhesion at Minimum Application Temperature, ASTM D1876 Modified, 880 N/m (5 lbs/in.);
- h. Peel Strength, ASTM D 903: Modified, 9 lbs/n;
- i. Resistance to Hydrostatic Head, ASTM D 5385:, 231 ft of water
- j. Water Absorption, ASTM D 570; 0.1% maximum.

#### 2.3.2 Primer

Asphalt composition, ASTM D 41, or synthetic polymer in solvent as recommended by the membrane manufacturer.

#### 2.3.3 Mastic

Polymer modified asphalt in suitable solvent of trowel-grade consistency and as recommended by the membrane manufacturer.

### 2.4 Protection Board

Provide protection board that is compatible with the waterproofing membrane. Use a minimum 1/4 inch thick board.

## PART 3 EXECUTION

### 3.1 VERIFICATION OF CONDITIONS

Before starting the work, verify that surfaces to be waterproofed are in satisfactory condition. Notify the Contracting Officer of defects or

conditions that will prevent a satisfactory application. Do not start application until defects and conditions have been corrected.

### 3.2 SURFACE PREPARATION

Ensure surfaces to be treated are clean, dry, smooth, and free from deleterious materials and projections. Thoroughly wet holes, joints, cracks, and voids in concrete with water and fill with Portland cement mortar, strike flush, and permit to dry. Cut off high spots or grind smooth. Sweep surfaces to be covered before applying waterproofing to remove dust and foreign matter. Cure concrete by a method compatible with the waterproofing system.

### 3.3 APPLICATION

Follow manufacturer's printed installation instructions. When using solvent welding liquid, avoid prolonged contact with skin and breathing of vapor. Provide adequate ventilation. Carry waterproofing of horizontal surfaces up abutting vertical surfaces as indicated and adhere solid to the substrate. Avoid wrinkles and buckles in applying membrane and joint reinforcement.

- a. Non-Self-Adhering Membrane: Unroll membrane and allow to remain flat for at least one-half hour before application. Apply an asphalt concrete primer prior to application of asphaltic adhesive. Where solvent adhesive is applied, allow major portion of solvent to evaporate so that bonding adhesive does not stick to a dry finger touching it. Apply elastomeric waterproofing membrane in a full bed of adhesive at a uniform coverage rate in accordance with the recommendations in the membrane manufacturer's printed instructions. Pull membrane tight without stretching. As soon as adhesive is fully set and dry, recheck lap splices. Where openings or fishmouths appear, reseal and reroll lap splices.
- b. Self-Adhering Membrane: Apply composite, self-adhering membrane on surfaces primed at a uniform coverage rate in accordance with membrane manufacturer's printed instructions. Remove release sheet and apply with tacky surface in contact with dried primer.
- c. Protection: Protect membrane over horizontal surfaces from abnormal traffic during installation. Use only equipment with rubber tires. Provide walkway protection where heavy traffic from other trades is expected. Do not store material on membrane.

#### 3.3.1 Butyl Rubber

Lap sheets at sides and ends a minimum of 6 inches over the preceding sheet. Apply lap splicing cement over entire 6 inches splice area prior to application of sealant. Sealant shall be continuous along the entire length of the splice. Maintain a continuous bead of sealant at all membrane splices or as required by the manufacturer. When membrane will be below water table, provide a tongue and groove cemented splice a minimum of 6 inches with factory made heat vulcanized seam not less than 2 inches or as required by the manufacturer.

### 3.4 Composite, Self-Adhering Membrane

Lap sheets at edges and ends a minimum of 2 1/2 inches over the preceding

sheet. All side laps shall be minimum 2 1/2 inches and end laps shall be 5 inches. Laps shall be self adhesive, mastic as per manufacturer's recommendation. Roll or firmly press to adhere membrane to substrate. Cover corners and joints with two layers of reinforcement by first applying a 12 inch width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of 6 inches from the drain or projection. Finish exposed, terminated edges of membrane on horizontal or vertical surfaces with a trowelled bead of mastic. Apply mastic around edges of membrane, and drains and projections. Apply mastic at end of each work day.

### 3.5 FLASHING

Flash penetrations through membrane. Ensure that where reinforcing bars penetrate a waterproofing membrane, each of those penetrations be sealed with the appropriate sealant or mastic flashing component. Embed elastomeric membrane in a heavy coat of adhesive, except for self-adhering membrane.

### 3.6 PROTECTIVE COVERING

After installation has been inspected and approved by the Contracting Officer, apply a protective covering to the membrane waterproofing prior to backfilling. Protect vertical membrane waterproofing with a 1/2 inch minimum thickness of asphalt plank; 1/2 inch minimum thickness of fiberboard; or 1/8 inch minimum thickness of compatible water-resistant bitumen type protection board with edges abutting adjacent edges and exposed surfaces covered by a taping system recommended by manufacturer of protection board.

-- End of Section --

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## SECTION 07212

## MINERAL FIBER BLANKET INSULATION

09/99

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## SECTION 07212

MINERAL FIBER BLANKET INSULATION  
09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 665	(1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 930	(1992) Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM E 84	(1998) Surface Burning Characteristics of Building Materials

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Thermal Blanket insulation

Sound attenuation blanket insulation

## SD-08 Manufacturer's Instructions

Each type of Insulation

## 1.3 DELIVERY, STORAGE, AND HANDLING

## 1.3.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type,

grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

#### 1.3.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

### 1.4 SAFETY PRECAUTIONS

#### 1.4.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

#### 1.4.2 Smoking

Do not smoke during installation of blanket thermal insulation.

#### 1.4.3 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C 930.

## PART 2 PRODUCTS

### 2.1 BLANKET INSULATION

#### 2.1.1 Thermal Insulation

ASTM C 665, Type II, blankets with non-reflecting coverings and Class A, membrane-faced surface with a flame spread of 25 or less and a smoke developed rating of 150 or less when tested in accordance with ASTM E 84.

##### 2.1.1.1 Thermal Resistance Value (R-VALUE)

R-value shall be as required to achieve the U-factor indicated on the drawings.

##### 2.1.1.2 Thickness

As required to achieve the U-factor indicated on the drawings.

#### 2.1.2 Sound Attenuation Blanket Insulation

ASTM C 665, Type I, blankets without membrane coverings. Size for friction fitting between metal framing members. Insulation in interior stud wall construction is considered "sound attenuation insulation."

##### 2.1.2.1 Thickness

As indicated on drawings. If not indicated, thickness shall fill the stud cavity.

### 2.1.3 Recycled Materials

Provide Insulation containing recycled materials to the extent practicable, provided the material meets all other requirements of this section. The minimum required recycled materials content by weight are:

Rock Wool: 75 percent slag  
Fiberglass: 20 to 25 percent glass cullet

### 2.1.4 Prohibited Materials

Do not provide asbestos-containing materials.

## PART 3 EXECUTION

### 3.1 EXISTING CONDITIONS

Before installing insulation, ensure that areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If moisture or other conditions are found that do not allow the workmanlike installation of the insulation, do not proceed but notify Contracting Officer of such conditions.

### 3.2 INSTALLATION

#### 3.2.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

##### 3.2.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical wiring between two layers of insulation.

##### 3.2.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, runner tracks, headers and any obstructions. Provide continuity and integrity of insulation. Avoid creating thermal bridges.

##### 3.2.1.3 Installation at Bridging

Butt insulation at bridging.

##### 3.2.1.4 Installation at Utilities

Place insulation to the outside of pipes and conduits.

##### 3.2.1.5 Thermal Insulation

Install insulation with vapor barrier on outside face (against sheathing). Provide snug friction fit to hold insulation in place in stud construction. Avoid gaps and bulges in insulation and "fishmouth" in vapor retarders. Stuff pieces of insulation into small cracks and voids.

3.2.1.6 Sound Attenuation Insulation

Provide snug friction fit to hold insulation in place. Stuff pieces of insulation into small cracks and voids.

3.2.1.7 Sizing of Blankets

Provide only full width blankets when insulating between studs. Size width of blankets for a snug fit.

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## SECTION 07240

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## SECTION 07240

EXTERIOR INSULATION AND FINISH SYSTEMS  
10/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 67	(2000) Sampling and Testing Brick and Structural Clay products
ASTM C 150	(2000) Portland Cement
ASTM C 473	(2000) Physical Testing of Gypsum Panel Products
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1177/C 1177M	(1999) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 3273	(2000) Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM E 84	(2000) Surface Burning Characteristics of Building Materials
ASTM E 330	(1997) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 331	(2000) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 695	(1997) Measuring Relative Resistance of

Wall, Floor, and Roof Construction to  
Impact Loading

ASTM G 23 (1996) Operating Light-Exposure Apparatus  
(Carbon-Arc Type) with and Without Water  
for Exposure of Nonmetallic Materials

EXTERIOR INSULATION MANUFACTURERS ASSOCIATION (EIMA)

EIMA TM 101.01 (1995) Freeze/Thaw Resistance of Exterior  
Insulation and Finish Systems (EIFS),  
Class PB.

EIMA TM 101.86 (1995, Rev. Aug. 1995) Resistance of  
Exterior Insulation and Finish Systems,  
Class PB, to the Effects of Rapid  
Deformation (Impact)

ASTM E 2098 (1995) Alkali Resistance of Glass Fiber  
Reinforcing Mesh for Use in Exterior  
Insulation and Finish Systems

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

UBC 26-4 Evaluation of Flammability Characteristics  
of Exterior, Non load-Bearing Wall Panel  
Assemblies using Foam Plastic Insulation

UBC 26-9 Evaluation of Flammability Characteristics  
of Exterior Non load-Bearing Wall  
Assemblies Containing Combustible  
Components using Intermediate-Scale,  
Multistory Test Apparatus Title

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 268 (1996) Determining Ignitability of  
Exterior Wall Assemblies Using a Radiant  
Heat Energy Source

## 1.2 SYSTEM DESCRIPTION AND REQUIREMENTS

The exterior insulation and finish system (EIFS) shall be a job-fabricated exterior wall covering consisting of sheathing, insulation board, reinforcing fabric, base coat, finish coat, adhesive and mechanical fasteners as applicable. The system components shall be compatible with each other and with the substrate as recommended or approved by, and the products of, a single manufacturer regularly engaged in furnishing Exterior Insulation and Finish Systems. All materials shall be installed by an applicator approved by the system manufacturer. EIFS shall be Class PB.

### 1.2.1 System Requirements and Tests

The system shall meet the performance requirements as verified by the tests listed below. Where a wall system of similar type, size, and design as specified for this project has been previously tested under the condition specified herein, the resulting test reports may be submitted in lieu of job specific tests.

#### 1.2.1.1 Water Penetration

Test the system for water penetration by uniform static air pressure in accordance with ASTM E 331. There shall be no penetration of water beyond the plane of the base coat/EPS board interface after 15 minutes at 6.4 psf), or 20% of positive design wind pressure, whichever is greater.

#### 1.2.1.2 Wind Load

Test the system for wind load by uniform static air pressure in accordance with ASTM E 330 (procedure A) to a minimum pressure produced by the design wind load indicated on the drawings. There shall be no permanent deformation, delamination, or other deterioration.

#### 1.2.1.3 Full scale or intermediate scale fire test

Conduct wall fire test using apparatus, specimen, performance criteria, and procedure in accordance with UBC 26-4. The specimen shall include the complete system using 102mm (4 inch) thick insulation board. At the option of the contractor, UBC 26-9, Intermediate-Scale Test may be substituted in lieu of the Full-Scale Multi-Story Fire test. The following requirements shall be met:

- a. No vertical spread of flame within core of panel from one story to the next.
- b. No flame spread over the exterior surface.
- c. No vertical flame spread over the interior surface from one story to the next.
- d. No significant lateral spread of flame from compartment of fire origin to adjacent spaces.

#### 1.2.2 Component Requirements and Tests

The components of the system shall meet the performance requirements as verified by the tests listed below.

##### 1.2.2.1 Surface Burning Characteristics

Conduct ASTM E 84 test on samples consisting of insulation board, base coat, reinforcing fabric, and finish coat. Cure for 28 days. The flame spread index shall be 25 or less and the smoke developed index shall be 450 or less.

##### 1.2.2.2 Radiant Heat

The system shall be tested in accordance with NFPA 268 with no ignition during the 20-minute period.

##### 1.2.2.3 Impact Resistance

- a. Class PB Systems: Hemispherical Head Test; 28 day cured specimen of PB EIFS in accordance with EIMA TM 101.86. The test specimen shall exhibit no broken reinforcing fabric per EIMA TM 101.86 at an impact of 49 in/lb.
- b. Impact Mass: Test 28 day cured specimen of PM EIFS in accordance

with ASTM E 695. The test specimen shall exhibit no cracking or denting after twelve impacts by 30 lbs lead shot mass from 6 in to 6 ft drop heights in 6 in intervals.

#### 1.2.3 Sub-Component Requirements and Tests

Unless otherwise stated, the test specimen shall consist of reinforcement, base coat, and finish coat applied in accordance with manufacturer's printed recommendations to the insulation board to be used on the building.

For mildew resistance, only the finish coat is applied onto glass slides for testing. These specimen shall be suitably sized for the apparatus used and be allowed to cure for a minimum of 28 days prior to testing.

##### 1.2.3.1 Abrasion Resistance

Test in accordance with ASTM D 968, Method A. Test a minimum of two specimen. After testing, the specimens shall show only very slight smoothing, with no loss of film integrity after 132 gallons of water.

##### 1.2.3.2 Accelerated Weathering

Test in accordance with ASTM G 23, Method 1. After 2000 hours specimens shall exhibit no visible cracking, flaking, peeling, blistering, yellowing, fading, or other such deterioration.

##### 1.2.3.3 Mildew Resistance

Test in accordance with ASTM D 3273. The specimen shall consist of the finish coat material, applied to clean 3 inch by 4 inch glass slides and shall be allowed to cure for 28 days. After 28 days of exposure, the specimen shall not show any growth.

##### 1.2.3.4 Salt Spray Resistance

Test in accordance with ASTM B 117. The specimen shall be a minimum of 4 inch by 6 inch and shall be tested for 300 hours. After exposure, the specimen shall exhibit no observable deterioration, such as chalking, fading , or rust staining.

##### 1.2.3.5 Water Resistance

Test in accordance with ASTM D 2247. The specimen shall be a minimum of 4 inch by 6 inch. After 14 days, the specimen shall exhibit no cracking, checking, crazing, erosion, blistering, peeling, or delamination.

##### 1.2.3.6 Absorption-Freeze/Thaw

Class PB systems shall be tested in accordance with EIMA TM 101.01 for 60 cycles of freezing and thawing. No cracking, checking, or splitting, and negligible weight gain. Class PM systems shall be tested in accordance with ASTM C 67 for 50 cycles of freezing and thawing. After testing, the specimens shall exhibit no cracking or checking, and have negligible weight gain.

##### 1.2.3.7 Sample Boards

Unless otherwise stated, provide sample EIFS Component 12 by 24 inches, on sheathing board, including finish color and texture, typical joints and sealant. If more than one color, finish, or pattern is used, provide one

sample for each. The test specimen shall consist of reinforcement, base coat, and finish coat applied in accordance with manufacturer's printed recommendations to the insulation board to be used on the building.

#### 1.2.4 Moisture Analysis

Perform a job specific vapor transmission analysis based on project specific climate and specified wall components and materials. Indicate the temperatures and relative humidities for the inside and outside of the building; a complete listing of the building components, their thickness, thermal resistance and permeance, as well as building location and use. If a mathematical model was used for the analysis, include the name of the model and the supplier/developer.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

###### Shop drawings

Show wall layout, construction and expansion joints, decorative grooves, layout of sheathing board, thermal insulation board, and reinforcement mesh and strip reinforcing fabric; joint and flashing details; details at wall penetrations; types and location of fasteners; details at windows and doors; and details at corners.

##### SD-03 Product Data

Sheathing board

Thermal insulation

Adhesive

Mechanical Fasteners

Accessories

Base coat

Portland cement

Reinforcing fabric

Finish coat

Joint Sealant

Primer

Bond breaker

Backer Rod

Insulation Board

Warranty

Include joint and other details, such as end conditions, corners and windows. Include shelf life and recommended cleaning solvents in data for sealants. Include material safety data sheets (MSDS) for all components of the EIFS. The MSDS shall be available at the job site.

SD-04 Samples

Sample Boards  
Color and Texture

SD-05 Design Data

Wind load Calculations

Moisture analysis Calculations

SD-06 Test Reports

Abrasion resistance

Accelerated weathering

Impact resistance

Mildew resistance

Salt spray resistance

Water vapor transmission

Absorption-freeze-thaw

wall fire test

Water penetration

Water resistance

Full scale or intermediate scale fire test

Surface Burning Characteristics

Radiant heat

substrate

Wind load

SD-07 Certificates

Qualifications of EIFS Manufacturer

Qualification of EIFS Installer



#### Qualification of Sealant Applicator

Certify that EIFS installer meets requirements specified under paragraph "Qualification of Installer," and that sealant applicator is approved by the EIFS Manufacturer.

#### Qualifications of Third Party Inspector

#### Inspection Check List

Submit filled-out inspection check list as required in paragraph "Quality Control," certifying that the installation of critical items meets the requirements of this specification.

#### SD-08 Manufacturer's Instructions

##### Installation

Manufacturer's standard printed instructions for the installation of the EIFS. Include requirements for condition and preparation of substrate, installation of EIFS, and requirements for sealants and sealing.

#### SD-10 Operation and Maintenance Data

##### EIFS

Include detailed finish repair procedures and information regarding compatibility of sealants with base and finish coatings.

### 1.4 QUALITY ASSURANCE

#### 1.4.1 Qualifications of EIFS Manufacturer

The EIFS shall be the product of a manufacturer who has been in the practice of manufacturing and designing EIFS for a period of not less than 3 years, and has been involved in at least five projects similar to this project in size, scope, and complexity, in the same or a similar climate as this project.

#### 1.4.2 Qualification of EIFS Installer

The EIFS Installer shall be trained and approved by the EIFS manufacturer to install the system and shall have successfully installed at least five projects at or near the size and complexity of this project. The contractor shall employ qualified workers trained and experienced in installing the manufacturer's EIFS.

#### 1.4.3 Qualification of Sealant Applicator

The sealant applicator shall be experienced and competent in the installation of high performance industrial and commercial sealants and shall have successfully installed at least five projects at or near the size and complexity of this project.

#### 1.4.4 Qualifications of Third Party Inspector

Submit evidence that third party inspector has current certification from

the Exterior Design Institute or equal inspector certification as inspector for the installation of EIFS.

#### 1.4.5 Insulation Board

Insulation Board shall be approved and labeled under third party quality program as required by applicable building code.

#### 1.4.6 Pre-Installation Conference

After approval of submittals and before commencing any work on the EIFS , including installation of any sheathing board, insulation, and associated work, the Contracting Officer will hold a pre-installation conference to review:

- a. Drawings, specifications, and samples;
- b. Procedure for on site inspection and acceptance of EIFS substrate and pertinent details;
- c. Contractor's plan for coordination of work of the various trades involved in providing EIFS system and other components;
- d. Inspection procedures; and
- e. Safety requirements.

Pre-installation conference shall be attended by the Contractor, EIFS Q.C.

Specialist (EIFS Inspector), and all personnel directly responsible for installation of the EIFS system, including sealant applicator, and personnel responsible for related work, such as flashing and sheet metal, windows and doors, and a representative of the EIFS manufacturer. Before beginning EIFS work, the contractor shall confirm in writing the resolution of conflicts among those attending the preinstallation conference.

#### 1.5 DELIVERY AND STORAGE

Deliver materials to job site in original unopened packages, marked with manufacturer's name, brand name, and description of contents. Store materials off the ground and in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area. Protect stored materials from rain, sunlight, and excessive heat. Keep coating materials which would be damaged by freezing at a temperature not less than 40 degrees F. Do not expose insulation board to flame or other ignition sources.

#### 1.6 ENVIRONMENTAL CONDITIONS

- a. Do not prepare materials or apply EIFS during inclement weather unless appropriate protection is provided. Protect installed materials from inclement weather until they are dry.
- b. Apply sealants and wet materials only at ambient temperatures of 40 degrees F or above and rising, unless supplemental heat is provided. The system shall be protected from inclement weather and to maintain this temperature for a minimum of 24 hours after installation.
- c. Do not leave insulation board exposed to sunlight after

installation.

#### 1.7 WARRANTY

Furnish manufacturer's standard warranty for the EIFS. Warranty shall run directly to Government and cover a period of not less than 5 years from date Government accepted the work.

### PART 2 PRODUCTS

#### 2.1 COMPATIBILITY

Provide all materials compatible with each other and with the substrate, and as recommended by EIFS manufacturer.

#### 2.2 SHEATHING BOARD

##### 2.2.1 Glass Mat Gypsum Sheathing Board

- a. Conform to ASTM C 1177/C 1177M.
- b. Nail Pull Resistance: No less than 120 lb when tested in accordance with ASTM C 473.

#### 2.3 ADHESIVE

Manufacturer's standard product, including primer as required, and shall be compatible with substrate and insulation board to which the system is applied.

#### 2.4 MECHANICAL FASTENERS

Corrosion resistant and as approved by EIFS manufacturer. Select fastener type and pattern based on applicable wind loads and substrate into which fastener will be attached, to provide the necessary pull-out, tensile, and shear strengths.

#### 2.5 THERMAL INSULATION

##### 2.5.1 Manufacturer's Recommendations

Provide only thermal insulation recommended by the EIFS manufacturer for the type of application intended.

##### 2.5.2 Insulation Board

Insulation board shall be standard product of manufacturer and shall be compatible with other systems components. Boards shall be factory marked individually with the manufacturer's name or trade mark, the material specification number, the R-value at 75 degree F, and thickness. No layer of insulation shall be less than 3/4 in thick. The maximum thickness of all layers shall not exceed 4 in. Insulation Board shall be certified as aged, in block form, prior to cutting and shipping, a minimum of 6 weeks by air drying, or equivalent.

- a. Thickness: As indicated on the drawings.
- b. Insulating material: ASTM C 578, Type I or IV, as recommended by the EIFS manufacturer and treated to be compatible with other EIFS

components. Age insulation by air drying a minimum of 6 weeks prior to cutting and shipping.

c. Base layer boards shall have drainage channels on inside face.

## 2.6 BASE COAT

Manufacturer's standard product and compatible with other systems components.

## 2.7 PORTLAND CEMENT

Conform to ASTM C 150, Type I or II as required, fresh and free of lumps, and approved by the systems manufacturer.

## 2.8 REINFORCING FABRIC

Reinforcing fabric mesh shall be alkali-resistant, balanced, open weave, glass fiber fabric made from twisted multi-end strands specifically treated for compatibility with the other system materials, and comply with ASTM E 2098 and as recommended by EIFS manufacturer.

## 2.9 FINISH COAT

Manufacturer's standard product conforming to the requirements in the paragraph on Sub-Component Requirements and Tests. For color consistency, use materials from the same batch or lot number. Color and texture shall be as indicated in the Finish Schedule on the drawings.

## 2.10 PRIMER

Non-staining, quick-drying type recommended by sealant manufacturer and EIFS manufacturer.

## 2.11 ACCESSORIES

Conform to recommendations of EIFS manufacturer, including trim, edging, anchors, expansion joints. All metal items and fasteners to be corrosion resistant.

## 2.12 JOINT SEALANT

Non-staining, quick-drying type meeting ASTM C 920, Class 25, compatible with the finish system type and grade, and recommended by both the sealant manufacturer and EIFS manufacturer.

## 2.13 BOND BREAKER

As required by EIFS manufacturer and recommended by sealant manufacturer and EIFS manufacturer.

## 2.14 BACKER ROD

Closed cell polyethylene free from oil or other staining elements and as recommended by sealant manufacturer and EIFS manufacturer. Do not use absorptive materials as backer rod. The backer rod should be sized 25 percent larger than the width of the joint.

## PART 3 EXECUTION

### 3.1 EXAMINATION

Examine substrate and existing conditions to determine that the EIFS can be installed as required by the EIFS manufacturer and that all work related to the EIFS is properly coordinated. Surface shall be sound and free of oil, loose materials or protrusions which will interfere with the system installation. If deficiencies are found, notify the Contracting Officer and do not proceed with installation until the deficiencies are corrected. The substrate shall be plane, with no deviation greater than 1/4 inch when tested with a 10 foot straightedge. Determine flatness, plumbness, and any other conditions for conformance to manufacturer's instructions.

### 3.2 SURFACE PREPARATION

Prepare existing surfaces for application of the EIFS to meet flatness tolerances and surface preparation according to manufacturer's installation instructions but provide a flatness of not more than 1/4 inch in 10 feet. Provide clean surfaces free of oil and loose material without protrusions adversely affecting the installation of the insulation board. For adhesively attached EIFS, existing deteriorated paint must be removed. Due to substrate conditions or as recommended by the system manufacturer, a primer may be required. Apply the primer to existing surfaces as recommended by the manufacturer. Use masking tape to protect areas adjacent to the EIFS to prevent base or finish coat to be applied to areas not intended to be covered with the EIFS. The contractor shall not proceed with the installation until all noted deficiencies of the substrate are corrected.

### 3.3 INSTALLATION

Install EIFS as indicated, comply with manufacturer's instructions except as otherwise specified, and in accordance with the shop drawings. EIFS shall be installed only by an applicator trained and approved by the EIFS manufacturer. Specifically, include all manufacturer recommended provisions regarding flashing and treatment of wall penetrations.

#### 3.3.1 Sheathing Board

Edges and ends of boards shall be butted snugly with vertical joints staggered to provide full and even support for the insulation. Do not align sheathing board joints with wall openings. Provide support at both vertical and horizontal joints. Attach sheathing board to metal studs with self-tapping drywall screws. Place fasteners sufficiently close to support imposed loads, but not more than 8 inches apart on each supporting stud.

Space fasteners more closely when required for negative wind load resistance.

#### 3.3.2 Insulation Board

Unless otherwise specified by the system manufacturer, place the long edge horizontally from level base line. Stagger vertical joints and interlock at corners. Butt joints tightly. Provide flush surfaces at joints. Offset insulation board joints from joints in sheathing by at least 8 inches.

Use L-shaped insulation board pieces at corners of openings. Joints of insulation shall be butted tightly. Surfaces of adjacent insulation boards shall be flush at joints. Gaps greater than 1/16 inch between the

insulation boards shall be filled with slivers of insulation. Uneven board surfaces with irregularities projecting more than 1/16 inch shall be rasped in accordance with the manufacturer's instructions to produce an even surface. Attach insulation board with mechanical fastener. Do not leave insulation board exposed longer than recommended by insulation manufacturer.

#### 3.3.2.1 Mechanically Fastened Insulation Boards

Fasten with manufacturer's standard corrosion resistant anchors, spaced as recommended by manufacturer, but not more than 2 feet horizontally and vertically.

#### 3.3.3 Base Coat and Reinforcing Fabric Mesh,

##### 3.3.3.1 Class PB Systems

Mix base coat in accordance with the manufacturer's instructions and apply to insulated wall surfaces to the thickness specified by the system manufacturer and provide any other reinforcement recommended by EIFS manufacturer. Trowel the reinforcing fabric mesh into the wet base coat material. Fully embed the mesh in the base coat. When properly worked-in, the pattern of the reinforcing fabric mesh shall not be visible. Provide diagonal reinforcement at opening corners. Back-wrap all terminations of the EIFS. Overlap the reinforcing fabric mesh a minimum of 2 inches on previously installed mesh, or butted, in accordance with the manufacturer's instructions. Allow the adhered insulation board to dry for 24 hours, or longer if necessary, prior to proceeding with the installation of the base coat/reinforcing fabric mesh. Install reinforcing fabric in accordance with and manufacturer's instructions.

#### 3.3.4 Finish Coat

Apply and level finish coat in one operation. Obtain final texture by trowels, floats, or by spray application as necessary to achieve the required finish matching approved sample. Apply the finish coat to the dry base coat maintaining a wet edge at all times to obtain a uniform appearance. The thickness of the finish coat shall be in accordance with the system manufacturer's current published instructions. Apply finish coat so that it does not cover surfaces to which joint sealants are to be applied. The base coat/reinforcing mesh must be allowed to dry a minimum of 24 hours prior to the application of the finish coat. Surface irregularities in the base coat, such as trowel marks, board lines, reinforcing mesh laps, etc., shall be corrected prior to application of the finish coat.

#### 3.4 JOINT SEALING

Seal EIFS at openings as recommended by the system manufacturer. Apply sealant only to the base coat. Do not apply sealant to the finish coat.

##### 3.4.1 Surface Preparation, Backer Rod, and Primer

Immediately prior to application, remove loose matter from joint. Ensure that joint is dry and free of paint, finish coat, or other foreign matter. Install backer rod. Apply primer as required by sealant and EIFS manufacturer. Check that joint width is as shown on drawings but in no case shall it be less than 0.5 inch for perimeter seals and 0.75 inch for expansion joints. The width shall not be less than 4 times the anticipated movement. Check sealant manufacturer's recommendations regarding proper

width to depth ratio.

### 3.4.2 Sealant

Apply sealant in accordance with sealant manufacturer's instructions with gun having nozzle that fits joint width. Do not use sealant that has exceeded shelf life or can not be discharged in a continuous flow. Completely fill the joint solidly with sealant without air pockets so that full contact is made with both sides of the joint. Tool sealant with a round instrument that provides a concave profile and a uniformly smooth and wrinkle free sealant surface. Do not wet tool the joint with soap, water, or any other liquid tooling aid. Do not apply sealant until all EIFS coatings are fully dry. During inclement weather, protect the joints until sealant application. Use particular caution in sealing joints between window and door frames and the EIFS wall and at all other wall penetrations. Clean all surfaces to remove excess sealant.

### 3.5 FIELD QUALITY CONTROL

Throughout the installation, the contractor shall establish and maintain an inspection procedure to assure compliance of the installed EIFS with contract requirements. Work not in compliance shall be removed and replaced or corrected in an approved manner. The inspection procedures, from acceptance of deliveries through installation of sealants and final acceptance shall be performed by qualified inspector trained by the manufacturer. No work on the EIFS shall be performed unless the inspector is present at the job site.

#### 3.5.1 Third Party Inspection

Provide full time third party inspection during the entire process of installing the EIFS, from examination through cleanup. The third party inspector shall be certified by the Exterior Design Institute (EDI) or by an equivalent independent party and shall be trained in the proper installation of EIFS.

#### 3.5.2 Inspection Check List

During the installation and at the completion of installation, perform inspections covering at the minimum all applicable items enumerated on the attached check list. The inspector shall initial and date all applicable items, sign the check list, and submit it to the Contracting Officer at the completion of the EIFS erection.

#### CHECK LIST

<u>Item</u>	<u>Description</u>	<u>Appr'd/Date</u>
a.	Materials are handled and stored correctly.	_____
b.	Environmental conditions are within specified limits, including temperature not below 40 degrees F, and the work is protected from the elements as required.	_____
c.	Preparation and installation is performed by qualified personnel using the correct tools.	_____
d.	Adjacent areas to which EIFS is not to be applied	_____

CHECK LIST

<u>Item</u>	<u>Description</u>	<u>Appr'd/Date</u>
	(such as on window and door frames) are protected with masking tape, plastic films, drop cloths, etc. to prevent accidental application of EIFS materials.	
e.	Control, expansion and aesthetic joints are installed as indicated or recommended. Accessories are properly installed.	
f.	Substrate is in-plane, properly attached, clean, dry, and free of contaminants. Concrete substrate is free of efflorescence.	
g.	Materials are mixed thoroughly and in proper proportions.	
h.	Adhesive is applied in sufficient quantity with proper-size notched trowel.	
i.	Mechanical attachments have proper spacing, layout and fastener depth.	
j.	Insulation boards are tightly abutted, in running bond pattern, with joints staggered with the sheathing, board corners interlocked, L-shaped boards around openings, edges free of adhesive, and provision for joints. Gaps are filled and surfaces rasped.	
k.	Insulation adhesive must be allowed to dry (a minimum of 24-hours) prior to the application of the finish coat.	
l.	Reinforcing fabric mesh is properly back-wrapped at terminations.	
m.	Reinforcing fabric mesh is fully embedded and properly placed. Corners are reinforced. Openings are diagonally reinforced. Mesh overlaps minimum 2-1/2 inches.	
n.	Base coat thickness is within specified limits.	
o.	The base coat/reinforcing fabric mesh must be allowed to dry a minimum of 24-hours prior to the application of the finish coat.	
p.	Finish coat is applied with sufficient number of personnel and stopped at suitable points. Floats and methods of texturing are uniform.	
q.	All Flashings are properly installed.	
r.	All joints are properly sealed in their entire length at time and under environmental conditions as specified by the manufacturer.	
s.	All scaffolding, equipment, materials, debris	



CHECK LIST

<u>Item</u>	<u>Description</u>	<u>Appr'd/Date</u>
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and temporary protection are removed from site  
upon completion.

Name of Inspector: \_\_\_\_\_ Signed: \_\_\_\_\_ Date: \_\_\_\_\_

## 3.6 CLEANUP

Upon completion, remove all scaffolding, equipment, materials and debris from site. Remove all temporary protection installed to facilitate installation of EIFS.

-- End of Section --

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## DIVISION 07 - THERMAL AND MOISTURE PROTECTION

## SECTION 07412A

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10/01

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## SECTION 07412A

## NON-STRUCTURAL METAL ROOFING

10/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(2000) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994e1) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences

	from Instrumentally Measured Color Coordinates
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 1999e1) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials

#### UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Feb 1998) Tests for Uplift Resistance of Roof Assemblies
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### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Metal Roofing; G, AE

a. Drawings consisting of catalog cuts, flashing details, erection drawings, shop coating and finishing specifications, and other data as necessary to clearly describe materials, sizes, layouts, construction details, fasteners, and erection. Drawings shall be provided by the metal roofing manufacturer.

b. Drawings showing the UL 580, Class 90 tested roof system assembly.

#### SD-04 Samples

##### Accessories

One sample of each type of flashing, trim, fascia, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

##### Roof Panels; G, AE

One piece of each type and finish to be used, 9 inches long, full width.

#### Fasteners

Two samples of each type to be used with statement regarding intended use. If so requested, random samples of screws, bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

#### Gaskets and Insulating Compounds

Two samples of each type to be used and descriptive data.

#### Sealant

One sample, approximately 1 pound, and descriptive data.

### SD-07 Certificates

#### Roof Panels Installation Accessories

Certificates attesting that the panels and accessories conform to the specified requirements. Certificate for the roof assembly shall certify that the assembly complies with the material and fabrication requirements specified and is suitable for the installation at the indicated design slope. Certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that at least 3 representative samples of similar material to that which will be provided on this project have been previously tested and have met the quality standards specified for factory color finish.

#### Insulation

Certificate attesting that the polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

#### Installer

Certification of installer.

#### Warranties

At the completion of the project, signed copies of the 5-year Warranty for Non-Structural Metal Roofing System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material and Weathertightness Warranties.

### 1.3 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies the specified design and additional requirements contained

herein. The roofing system shall be provided by the Contractor as a complete system, as tested and approved in accordance with UL 580. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

#### 1.3.1 Non-Structural Metal Roof System

The Non-Structural Metal Roof System covered under this specification shall include the entire roofing system; the metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with UL 580. The system shall be installed on a substrate specified in Section 05300A STEEL DECKING. In addition, the system shall consist of panel finishes, slip sheet, insulation, soffits, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents and curbs; gutters and downspouts, eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the system.

#### 1.3.2 Manufacturer

The non-structural metal roofing system shall be the product of a manufacturer who has been in the practice of manufacturing metal roofs for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

#### 1.3.3 Installer

The installer shall be certified by the metal roof manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

#### 1.4 DESIGN LOADS

Non-structural Metal Roof System assemblies shall be tested as defined in UL 580 and shall be capable of resisting the wind uplift pressures shown on the contract drawings or, as a minimum, shall be approved to resist wind uplift pressures of UL 580, Class 90.

#### 1.5 PERFORMANCE REQUIREMENTS

The metal roofing system supplied shall conform to the roof slope, the underlayment, and uplift pressures shown on the contract drawings. The Contractor shall furnish a commercially available roofing system which satisfies all the specified requirements.

#### 1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weather tight coverings and kept dry. Material shall not be covered with plastic where such covering will allow sweating and condensation. Plastic may be used as tenting with air circulation allowed. Storage conditions shall provide good air circulation and protection from surface staining.

## 1.7 WARRANTIES

The Non-Structural Metal Roofing System shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

### 1.7.1 Contractor's Weathertightness Warranty

The Non-Structural Metal Roofing System shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The roofing covered under this warranty shall include the entire roofing system, including but not limited to, the roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with UL 580. In addition, the system shall consist of panel finishes, slip sheet, insulation, soffits, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs; gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the roof system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects.

This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the 5 year Contractor's warranty period for the entire roofing system as outlined above.

### 1.7.2 Manufacturer's Material Warranties

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all Non-Structural Metal Roofing System components such as roof panels, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, fail structurally, or perforate under normal atmospheric conditions at the site. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty warranting that the factory color finish, under normal atmospheric



conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D 4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing or replacing the defective coated coil material.

c. A roofing system manufacturer's 20 year system weathertightness warranty.

#### 1.8 COORDINATION MEETING

A coordination meeting shall be held within 45 days after contract award for mutual understanding of the metal roofing system contract requirements.

This meeting shall take place at the building site and shall include representatives from the Contractor, the roofing system manufacturer, the roofing supplier, the erector, the designer, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

### PART 2 PRODUCTS

#### 2.1 ROOF PANELS

Panels shall be steel and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 30 feet. Sheets longer than 30 feet may be furnished if approved by the Contracting Officer. Width of sheets shall provide nominal 12 inches of coverage in place. Design provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. All sheets shall be either square-cut or miter-cut. The ridge cap shall be installed as recommended by the metal roofing manufacturer. Height of seams at overlap of adjacent roof sheets shall be a minimum of 1 1/2 inches. Seams shall be a snap-lock standing seam design which utilizes an integral hold-down clip. Separate snap-on battens are not acceptable.

##### 2.1.1 Steel Panels

Zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 50 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Uncoated roof panels shall be 24 gage or heavier. Panels shall be within 95 percent of the nominal thickness.

#### 2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

#### 2.3 ACCESSORIES

Accessories shall be compatible with the roofing furnished. Flashing, trim, soffits, gutters, downspouts, fascia, metal closure strips, caps, and

similar metal accessories shall be not less than the minimum gage specified for roof panels. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water.

#### 2.4 FASTENERS

Fasteners for roof panels shall be zinc-coated steel, aluminum, or nylon capped steel, type and size as recommended by the manufacturer to meet the performance requirements. Fasteners for accessories shall be the manufacturer's standard. Exposed fasteners for accessories shall be gasketed or have gasketed washers on the exterior side of the roofing to waterproof the fastener penetration. Washer material shall be compatible with the panels; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick.

#### 2.5 FACTORY COLOR FINISH

Panels shall have a factory applied three-coat polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a specially formulated rust-inhibitive primer, a fluoropolymer color coat, and a clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride by weight. The exterior coating shall have a minimum dry film thickness of not less than 1.5 mil. The exterior color finish shall meet the test requirements specified below.

##### 2.5.1 Cyclic Salt Fog/UV Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 1/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

##### 2.5.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

##### 2.5.3 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

##### 2.5.4 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

#### 2.5.5 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

#### 2.5.6 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

### 2.6 UNDERLAYMENTS

#### 2.6.1 Felt Underlayment

Felt underlayment shall be No. 30 felt in accordance with ASTM D 226, Type II.

#### 2.6.2 Rubberized Underlayment

Rubberized underlayment shall be equal to "Ice and Water Shield" as manufactured by Grace Construction Products, "Winterguard" as manufactured by CertainTeed Corporation, or "Weather Watch Ice and Water Barrier" as manufactured by GAF Building Materials Corporation.

#### 2.6.3 Slip Sheet

Slip Sheet shall be 5 pounds per 100 sf rosin sized unsaturated building paper.

### 2.7 INSULATION

Thermal resistance (R-value) of insulation shall be not less than required to achieve the U-value indicated on the drawings. R-values shall be determined at a mean temperature of 75 degrees F in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation shall have a flame spread not in excess of 75 and a smoke developed rating not in excess of 450 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory. Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

#### 2.7.1 Rigid Board Insulation for Use Above a Roof Deck

##### 2.7.1.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2. For impermeable faced polyisocyanurate (Ex: aluminum foil) the maximum design R-value per 1 inch of insulation used shall be 7.2.

### 2.8 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed

sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

## 2.9 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

#### 3.1.1 Roofing

End lap distances, joint sealing, and fastening of accessories and spacing of fasteners shall be in accordance with manufacturer's standard practice. Spacing of exposed fasteners shall present an orderly appearance. Exposed fasteners are not allowed in roofing panels except for attachment of accessories. Side laps and end laps of roof panels and joints at accessories shall be sealed. Fasteners shall be driven normal to the surface. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weathertight installation. Accessories shall be fastened into substrate, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

#### 3.1.2 Field Forming of Roof Panels for Unique Areas

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's approved installer. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

#### 3.1.3 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the structural metal deck. The maximum distance, parallel to the seams, between clips shall be 30 inches on center at the corner, edge, and ridge zones, and 5 feet maximum on centers for the remainder of the roof. Anchor clips may also be placed on load distribution plates on top of insulation and fastened through to the structural metal deck. Where plywood is indicated as a substrate in lieu of insulation, anchor clips shall be fastened through the plywood to the structural metal deck.

#### 3.1.4 Underlayment

Felt underlayment shall be provided over all plywood substrates and rubberized underlayment shall be provided over all insulation substrates; they shall be installed directly over the substrate. A slip sheet shall be installed as a top layer, beneath the metal roofing panels, to prevent adhesion. All underlayments shall be installed so that successive strips overlap the next lower strip in shingle fashion. Underlayments shall be installed in accordance with the manufacturer's written instructions. The underlayments shall ensure that any water that penetrates below the metal roofing panels will drain outside of the building envelope.

#### 3.2 INSULATION INSTALLATION

Insulation shall be installed as indicated and in accordance with manufacturer's instructions. Insulation shall be continuous over entire roof surface. Board insulation shall be laid in close contact. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. Rigid insulation shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, with no less than 1 fastener and bearing plates per 4 square feet of insulation. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings.

#### 3.3 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

#### 3.4 SLIP SHEET INSTALLATION

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON-STRUCTURAL METAL ROOF SYSTEM

FACILITY DESCRIPTION \_\_\_\_\_

BUILDING NUMBER: \_\_\_\_\_

CORPS OF ENGINEERS CONTRACT NUMBER: \_\_\_\_\_

CONTRACTOR

CONTRACTOR: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

OWNER

OWNER: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONSTRUCTION AGENT

CONSTRUCTION AGENT: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON-STRUCTURAL METAL ROOF SYSTEM  
(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY \_\_\_\_\_ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE NON-STRUCTURAL METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH UL 580. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE NON-STRUCTURAL METAL ROOFING SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE NON-STRUCTURAL METAL ROOF SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON \_\_\_\_\_ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

\_\_\_\_\_  
(Company President)

\_\_\_\_\_  
(Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON-STRUCTURAL METAL ROOFING SYSTEM  
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOFING SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).
2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.
3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.
4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.
5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.
6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOFING SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.
7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

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CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON-STRUCTURAL METAL ROOF SYSTEM  
(continued)

\*\*REPORTS OF LEAKS AND ROOF SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS ROOF SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE NON-STRUCTURAL METAL ROOF SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07840

FIRESTOPPING

06/03

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## SECTION 07840

## FIRESTOPPING

06/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by basic designation only.

## ASTM INTERNATIONAL (ASTM)

ASTM E 84	(2001) Surface Burning Characteristics of Building Materials
ASTM E 119	(2000a) Fire Tests of Building Construction and Materials
ASTM E 814	(2002) Fire Tests of Through-Penetration Fire Stops
ASTM E 1399	(1997; R 2000) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E 1966	(2001) Fire-Resistive Joint Systems

## FM GLOBAL (FM)

FM P7825a	(2003) Approval Guide Fire Protection
FM Standard 4991	(2003) FM Contractor Approval Standard

## UNDERWRITERS LABORATORIES (UL)

UL 723	(1996; Rev thru Sep 2001) Test for Surface Burning Characteristics of Building Materials
UL 1479	(1994; Rev thru Aug 2000) Fire Tests of Through-Penetration Firestops
UL 2079	(1998) Tests for Fire Resistance of Building Joint Systems
UL Fire Resist Dir	(2001) Fire Resistance Directory (2 Vol.)

## 1.2 SUBMITTALS

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Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials; G, RE.

Detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resist Dir or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" and "T" ratings, and type of application.

SD-07 Certificates

Firestopping Materials.

Certificates attesting that firestopping material complies with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate nationally recognized independent laboratory may be substituted.

Installer Qualifications.

Documentation of training and experience.

Inspection.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the top of the fire-rated walls and the roof or floor deck above.

#### 1.4 DELIVERY AND STORAGE

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

#### 1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is:

- a. FM Research approved in accordance with FM Standard 4991, or
- b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

#### 1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

### PART 2 PRODUCTS

#### 2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free, containing no water soluble intumescent ingredients, noncombustible products FM P7825a approved for use with applicable construction and penetrating items, complying with the following minimum requirements:

##### 2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resist Dir or by a nationally recognized testing laboratory.

##### 2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application or during fire conditions.

### 2.1.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resist Dir listed or FM P7825a approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Firestop systems shall also have "T" rating where required.

#### 2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479. Fire resistance ratings shall be as follows:

- a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = Rating of wall or partition being penetrated.
- b. Penetrations of Fire Resistance Rated Floors: F Rating = Fire rating of floor being penetrated.

#### 2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119, ASTM E 1966 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079.

## PART 3 EXECUTION

### 3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device. Surfaces shall be prepared as recommended by the manufacturer.

### 3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

- a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls and partitions.
- b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

- c. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of the structure above.
- d. Construction joints in floors and fire rated walls and partitions.
- e. Other locations where required to maintain fire resistance rating of the construction.

### 3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

### 3.2.2 Fire Dampers

Fire dampers shall be installed and firestopped in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

### 3.2.3 Data and Communication Cabling

Cabling for data and communication applications shall be sealed with re-enterable firestopping products that do not cure over time. Firestopping shall be modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves, adds or changes without the need to remove or replace any firestop materials.

## 3.3 INSPECTION

The firestopped areas shall not be covered or enclosed until inspection is complete and approved by the manufacturer's technical representative. The manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. The Contractor shall submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers.

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## SECTION 07900A

## JOINT SEALING

06/97

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## SECTION 07900A

## JOINT SEALING

06/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 217	(1997) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Backing.

Bond-Breaker.

Sealant.

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

## SD-07 Certificates

Sealant.

Certificates of compliance stating that the materials conform to the specified requirements.

## 1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 40 to 90 degrees F when the sealants are applied.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 40 and 90 degrees F unless otherwise specified by the manufacturer.

## PART 2 PRODUCTS

## 2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell material. Provide one of the following types.

## 2.1.1 Rubber

Cellular rubber sponge backing shall be ASTM D 1056, Type 2, closed cell, Class A, Grade 3 or higher, round cross section.

## 2.1.2 Synthetic Rubber

Synthetic rubber backing shall be ASTM C 509, Option I, Type I preformed rods.

## 2.1.3 Neoprene

Neoprene backing shall be ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2.

## 2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

## 2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

## 2.4 SEALANT

### 2.4.1 LATEX

Latex Sealant shall comply with ASTM C 834 and shall be paintable. Use for all general interior caulking and sealing applications.

### 2.4.2 ELASTOMERIC

Exterior sealants shall be elastomeric sealants and shall conform to ASTM C 920 and the following:

- a. Polyurethane sealant: Grade NS, Class 25 Use NT, M and O, as applicable. Use where both sides of joint are masonry, concrete, EIFS, or a combination.
- b. Silicone sealant: Type S or M, Grade NS, Class 25, Use NT, M, G A, and O, as applicable. Use where one or both sides of joint are metal such as at aluminum storefront work.

### 2.4.3 ACOUSTICAL

Rubber or polymer-based acoustical sealant shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant shall have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and shall remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and shall be non-staining. Use only for sealing of perimeters and penetrations in sound rated partitions.

### 2.4.4 PREFORMED

Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant shall be non-bleeding and shall have no loss of adhesion. Cross-section dimensions shall be as required by joint configuration.

#### 2.4.4.1 Foam Strip

Foam strip shall be polyurethane foam; cross-section dimensions shall be as required to suit joint dimensions. Foam strip shall be capable of sealing out moisture, air, and dust when installed and compressed as recommended by the manufacturer. Service temperature shall be minus 40 to plus 275 degrees F. Untreated strips shall be furnished with adhesive to hold them in place. Adhesive shall not stain or bleed into adjacent finishes. Treated strips shall be saturated with butylene waterproofing or impregnated with asphalt.

## 2.5 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

## PART 3 EXECUTION

### 3.1 GENERAL

#### 3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant.

Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

#### 3.1.2 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

#### 3.1.3 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

#### 3.1.4 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

#### 3.1.5 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

### 3.2 APPLICATION

#### 3.2.1 Masking Tape

Masking tape may be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

#### 3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

### 3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

### 3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

### 3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

## 3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

-- End of Section --

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## DIVISION 08 - DOORS AND WINDOWS

## SECTION 08110

## STEEL DOORS AND FRAMES

05/01

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## SECTION 08110

## STEEL DOORS AND FRAMES

05/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |             |  |
|-------------|--|
| ANSI A250.6 | (1997) Hardware on Standard Steel Doors<br>(Reinforcement - Application)         |
| ANSI A250.8 | (1998) SDI-100 Recommended Specifications<br>for Standard Steel Doors and Frames |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |                   |  |
|-------------------|--|
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated<br>(Galvanized) or Zinc-Iron Alloy-Coated<br>(Galvannealed) by the Hot-Dip Process |
| ASTM A 924/A 924M | (1999) General Requirements for Steel<br>Sheet, Metallic-Coated by the Hot-Dip<br>Process                          |

## DOOR AND HARDWARE INSTITUTE (DHI)

- |           |   |
|-----------|---|
| BHMA A115 | (1991) Steel Door Preparation Standards<br>(Consisting of A115.1 through A115.6 and<br>A115.12 through A115.18) |
|-----------|---|

## HOLLOW METAL MANUFACTURERS ASSOCIATION (HMMA)

- |                |                            |
|----------------|----------------------------|
| NAAMM HMMA HMM | (1992) Hollow Metal Manual |
|----------------|----------------------------|

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- |          |   |
|----------|---|
| NFPA 80  | (1999) Fire Doors and Fire Windows                          |
| NFPA 105 | (1999) The Installation of Smoke-Control<br>Door Assemblies |
| NFPA 252 | (1999) Standard Methods of Fire Tests of<br>Door Assemblies |

## STEEL DOOR INSTITUTE (SDOI)

- |         |  |
|---------|--|
| SDI 105 | (1998) Recommended Erection Instructions |
|---------|--|

## for Steel Frames

## UNDERWRITERS LABORATORIES (UL)

UL 10B

(1997) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Doors

Frames

Accessories

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors

Schedule of frames

Submit door and frame locations.

## SD-03 Product Data

Doors

Frames

Accessories

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to ANSI A250.8 requirements.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.



## PART 2 PRODUCTS

### 2.1 STANDARD STEEL DOORS

ANSI A250.8, except as specified otherwise. Prepare doors to receive hardware specified in Section 08710, "Door Hardware." Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 1 3/4 inches thick, unless otherwise indicated.

#### 2.1.1 Classification - Level, Performance, Model

##### 2.1.1.1 Extra Heavy Duty Doors

ANSI A250.8, Level 3, physical performance Level A, Model 1 or 2 with core construction as required by the manufacturer and of size(s) and design(s) indicated. Where vertical stiffenercores are required, the space between the stiffeners shall be filled with mineral board insulation.

### 2.2 CUSTOM HOLLOW METAL DOORS

At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design, materials, construction, gages, and finish shall be as specified for standard steel doors and shall comply with the requirement of NAAMM HMMA HMM. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 16 gage. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section 08710, "Door Hardware." Doors shall be 1 3/4 inches thick, unless otherwise indicated.

### 2.3 ACCESSORIES

#### 2.3.1 Astragals

For pairs of exterior steel doors which will not have removable mullions, as specified in Section 08710, "Door Hardware," provide overlapping steel astragals with the doors.

#### 2.3.2 Moldings

Provide moldings around glass of interior and exterior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings.

### 2.4 STANDARD STEEL FRAMES

ANSI A250.8, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for wood and steel doors, transoms, sidelights, mullions, cased openings, and interior glazed panels, unless otherwise indicated. Door frames shall be 16 gage minimum; view panel frames shall be 18 gage minimum.

#### 2.4.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

#### 2.4.2 Mullions and Transom Bars

Mullions and transom bars shall be closed or tubular construction and shall member with heads and jambs and butt-welded thereto. Bottom of door mullions shall have adjustable floor anchors and spreader connections.

#### 2.4.3 Stops and Beads

Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inches on centers. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

#### 2.4.4 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

#### 2.4.5 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.

##### 2.4.5.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

- a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;
- b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws. Attach each anchor strap to each stud of the double jamb studs.

##### 2.4.5.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member; configure as indicated on drawings.

#### 2.5 FIRE AND SMOKE DOORS AND FRAMES

NFPA 80 and NFPA 105 and this specification. The requirements of NFPA 80 and NFPA 105 shall take precedence over details indicated or specified.

##### 2.5.1 Labels

Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10B. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames

and to the hinge edge of the door. Door labels shall not be painted.

#### 2.5.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

#### 2.5.3 Astragal on Fire and Smoke Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements. On smoke control doors, conform to NFPA 105.

#### 2.6 WEATHERSTRIPPING

As specified in Section 08710, "Door Hardware."

#### 2.7 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in ANSI A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of ANSI A250.8 and ANSI A250.6. For additional requirements refer to BHMA A115.

Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of ANSI A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

#### 2.8 FINISHES

##### 2.8.1 Factory-Primed Finish

All surfaces of interior steel doors and frames shall be thoroughly cleaned, chemically treated and factory primed after fabrication with a rust inhibiting coating as specified in ANSI A250.8, or paintable A25 galvanized steel without primer. Where coating is removed by welding, apply touchup of factory primer.

##### 2.8.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate exterior steel doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A 924/A 924M and ASTM A 653/A 653M. The Coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in ANSI A250.8.

#### 2.9 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed

welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness. Design other frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive calking compound.

#### 2.9.1 Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Frames

Set frames in accordance with SDI 105. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

##### 3.1.2 Doors

Hang doors in accordance with clearances specified in ANSI A250.8. After erection and glazing, clean and adjust hardware.

##### 3.1.3 Fire and Smoke Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated smoke doors and frames in accordance with NFPA 80 and NFPA 105.

#### 3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

#### 3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

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## SECTION 08120

## ALUMINUM DOORS, FRAMES AND STOREFRONT

09/99

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## SECTION 08120

ALUMINUM DOORS, FRAMES AND STOREFRONT  
09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

- |             |   |
|-------------|---|
| AAMA 1503.1 | (1988) Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections |
| AAMA 2604   | (1992; Addendum 1995) High Performance Organic Coatings on Architectural Extrusions and Panels      |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |                 |  |
|-----------------|--|
| ASTM A 36/A 36M | (1997; Rev. A) Carbon Structural Steel   |
| ASTM B 209      | (1996) Aluminum and Aluminum-Alloy Sheet and Plate   |
| ASTM B 221      | (1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes  |
| ASTM C 236      | (1989; R 1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box                                   |
| ASTM E 283      | (1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM E 331      | (1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference                       |

## 1.2 PERFORMANCE REQUIREMENTS

## 1.2.1 Structural

Shapes and thicknesses of framing members shall be sufficient to withstand the design wind load indicated with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65. Provide glazing beads, moldings, and trim of not less than 0.050 inch nominal thickness.

### 1.2.2 Air Infiltration

When tested in accordance with ASTM E 283, air infiltration shall not exceed 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 6.24 pounds per square foot (50 mile per hour wind).

### 1.2.3 Water Penetration

When tested in accordance with ASTM E 331, there shall be no water penetration at a pressure of 8 pounds per square foot of fixed area.

### 1.2.4 Thermal Performance

#### 1.2.4.1 Condensation Resistance Factor

When tested in accordance with AAMA 1503.1, the condensation resistance factor shall be a minimum of 76 for aluminum framing and 56 for glass.

#### 1.2.4.2 Thermal Transmittance

When tested in accordance with AAMA 1503.1 and ASTM C 236, the thermal transmittance due to conduction shall be 0.58.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Doors and framing

Show elevations of each storefront panel and door type, size of doors and frames, metal gages, details of door and frame construction, methods of anchorage, glazing details, weatherstripping, provisions for and location of hardware, and details of installation.

#### SD-08 Manufacturer's Instructions

##### Doors and framing

Submit detail specifications and instructions for installation, adjustments, cleaning, and maintenance.

### 1.4 SYSTEM REQUIREMENTS

Provide a system that includes aluminum stile and rail doors and an aluminum stick framing system for doors as well as sidelights, transoms, and storefront framing. Include all necessary trim, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing framing members to adjacent construction.

#### 1.4.1 Source

Primary system components shall be the products of one manufacturer.



## 1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage. Unload and store with minimum handling. Provide storage space in dry location with adequate ventilation, free from dust or water, and easily accessible for inspection and handling. Stack materials on nonabsorptive strips or wood platforms. Do not cover doors and frames with tarps, polyethylene film, or similar coverings. Protect finished surfaces during shipping and handling using manufacturer's standard method, except that no coatings or lacquers shall be applied to surfaces to which calking and glazing compounds must adhere.

## PART 2 PRODUCTS

### 2.1 DOORS AND FRAMING

Swing-type aluminum doors and framing members of size, design, and location indicated. Provide doors complete with frames, framing members, transoms, adjoining sidelights and stand-alone storefront, trim, and accessories.

### 2.2 MATERIALS

#### 2.2.1 Anchors

Stainless steel or steel with hot-dipped galvanized finish.

#### 2.2.2 Weatherstripping

Continuous wool pile, silicone treated, or type recommended by door manufacturer.

#### 2.2.3 Aluminum Alloy for Doors and Framing

ASTM B 221, Alloy 6063-T5 for extrusions. ASTM B 209, alloy and temper best suited for aluminum sheets and strips.

#### 2.2.4 Fasteners

Hard aluminum or stainless steel.

#### 2.2.5 Structural Steel

ASTM A 36/A 36M.

#### 2.2.6 Aluminum Paint

Type as recommended by aluminum door manufacturer.

### 2.3 FABRICATION

#### 2.3.1 Aluminum Framing

Extruded aluminum shapes with dimensions and cross-sections as indicated. System shall be designed for pressure glazing from the outside. Use countersunk stainless steel Phillips screws for exposed fastenings, and space not more than 12 inches o.c. Mill joints in frame members to a hairline fit, reinforce, and secure mechanically. Frames shall be thermally broken to isolate interior surfaces from exterior surfaces. Frames shall provide for flush glazing on all sides without projecting

stops. Entrance framing members shall be compatible with glass framing members in appearance and fit.

### 2.3.2 Aluminum Doors

Of type, size, and design indicated and not less than 1 3/4 inches thick. Minimum wall thickness, 0.125 inch, except beads and trim, 0.050 inch. Door sizes shown are nominal and shall include standard clearances as follows: 0.093 inch at hinge and lock stiles, 0.125 inch between meeting stiles, 0.125 inch at top rails, 0.187 inch between bottom and threshold, and 0.687 inch between bottom and floor. Bevel single-acting doors 0.063 or 0.125 inch at lock, hinge, and meeting stile edges.

#### 2.3.2.1 Full Glazed Stile and Rail Doors

Doors shall have medium stiles and rails unless otherwise indicated. Fabricate from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Fasten top and bottom rail together by means of welding or by 3/8 or 1/2 inch diameter cadmium-plated tensioned steel tie rods. Provide an adjustable mechanism of jack screws or other methods in the top rail to allow for minor clearance adjustments after installation.

### 2.3.3 Welding and Fastening

Where possible, locate welds on unexposed surfaces. Dress welds on exposed surfaces smoothly. Select welding rods, filler wire, and flux to produce a uniform texture and color in finished work. Remove flux and spatter from surfaces immediately after welding. Exposed screws or bolts will be permitted only in inconspicuous locations, and shall have countersunk heads. Weld concealed reinforcements for hardware in place.

### 2.3.4 Weatherstripping

Provide on stiles and rails of exterior doors. Fit into slots which are integral with doors or frames. Weatherstripping shall be replaceable without special tools, and adjustable at meeting rails of pairs of doors. Installation shall allow doors to swing freely and close positively. Air leakage of a single leaf weatherstripped door shall not exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283.

### 2.3.5 Anchors

Provide anchors of the sizes and shapes required for securing frames to adjacent construction. Anchor transom bars at ends and mullions at head and sill. Where required, reinforce vertical mullions with structural steel members of sufficient length to extend up to the overhead structural slab or framing and secure thereto. Reinforce and anchor freestanding door frames to floor construction as indicated on approved shop drawings and in accordance with manufacturer's recommendation. Place anchors near top and bottom of each jamb and at intermediate points not more than 25 inches apart.

### 2.3.6 Provisions for Hardware

Hardware is specified in Section 08710, "Door Hardware." Deliver hardware templates and hardware (except field-applied hardware) to the door manufacturer for use in fabrication of aluminum doors and frames. Cut,

reinforce, drill, and tap doors and frames at the factory to receive template hardware. Provide doors to receive surface-applied hardware with reinforcing only; drill and tap in the field. Provide hardware reinforcements of stainless steel or steel with hot-dipped galvanized finish, and secure with stainless steel screws.

### 2.3.7 Provisions for Glazing

#### 2.3.7.1 Glazing Beads

Provide extruded aluminum snap-in glazing beads on interior side of doors. Provide extruded aluminum, theft-proof, snap-in glazing beads or fixed glazing beads on exterior or security side of doors. Glazing beads shall have vinyl insert glazing gaskets. Design glazing beads to receive glass of thickness indicated or specified. Glazing is specified in Section 08810A, "Glass and Glazing."

#### 2.3.7.2 Storefront

Glass shall be set with glazing gaskets consisting of elastomeric material other than vinyl. Gaskets shall be of a type that lock securely into glazing reglets to prevent gaskets from dislodging.

### 2.3.8 Finishes

Provide exposed aluminum surfaces with a factory applied organic coating.

#### 2.3.8.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a high-performance finish in accordance with AAMA 2604 with total dry film thickness of not less than 1.2 mils. The finish color shall be as indicated. The intent is to match color on existing adjacent buildings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Plumb, square, level, and align frames and framing members to receive door, transoms, adjoining sidelights, and adjoining or stand-alone storefront. Anchor frames to adjacent construction as indicated and in accordance with manufacturer's printed instructions. Anchor bottom of each frame to rough floor construction with 3/32 inch thick stainless steel angle clips secured to back of each jamb and to floor construction; use stainless steel bolts and expansion rivets for fastening clip anchors. Seal metal-to-metal joints between framing members as specified in Section 07900A, "Joint Sealing." Hang doors to produce clearances specified in paragraph entitled "Aluminum Doors," of this section. After erection and glazing, adjust doors and hardware to operate properly.

### 3.2 PROTECTION FROM DISSIMILAR MATERIALS

#### 3.2.1 Dissimilar Metals

Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by one or a combination of the following methods:

- a. Paint the dissimilar metal with one coat of heavy-bodied

bituminous paint.

- b. Apply a good quality elastomeric sealant between the aluminum and the dissimilar metal.
- c. Paint the dissimilar metal with one coat of primer and one coat of aluminum paint.
- d. Use a nonabsorptive tape or gasket in permanently dry locations.

### 3.2.2 Drainage from Dissimilar Metals

In locations where drainage from dissimilar metals has direct contact with aluminum, provide protective paint, to prevent aluminum discoloration.

### 3.2.3 Masonry and Concrete

Provide aluminum surfaces in contact with mortar, concrete, or other masonry materials with one coat of heavy-bodied bituminous paint.

### 3.2.4 Wood or Other Absorptive Materials

Provide aluminum surfaces in contact with absorptive materials subject to frequent moisture, and aluminum surfaces in contact with treated wood, with two coats of aluminum paint or one coat of heavy-bodied bituminous paint. In lieu of painting the aluminum, the Contractor shall have the option of painting the wood or other absorptive surface with two coats of aluminum paint and sealing the joints with elastomeric sealant.

## 3.3 CLEANING

Upon completion of installation, clean door and frame surfaces in accordance with door manufacturer's recommended procedure. Do not use abrasive, caustic, or acid cleaning agents.

## 3.4 PROTECTION

Protect doors and framing from damage and from contamination by other materials such as cement mortar. Prior to completion and acceptance of the work, restore damaged doors and framing to original condition, or replace with new ones.

-- End of Section --

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SECTION 08210

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09/99

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## SECTION 08210

WOOD DOORS  
09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 152 (1981; Rev. A) Fire Tests of Door Assemblies

## ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI Qual Stds (1997) Architectural Woodwork Quality Standards and Quality Certification Program

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1995) Fire Doors and Fire Windows

NFPA 252 (1995) Fire Tests of Door Assemblies

## WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S. 1-A (1993) Architectural Wood Flush Doors

WDMA TM-5 (1990) Split Resistance Test

WDMA TM-7 (1990) Cycle - Slam Test

WDMA TM-8 (1990) Hinge Loading Resistance Test

## UNDERWRITERS LABORATORIES (UL)

UL 10B (1997) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors

Submit drawings or catalog data showing each type of door unit.

Drawings and data shall indicate door type and construction, sizes, thickness, methods of assembly, door louvers (if any), and glazing.

#### SD-03 Product Data

Doors

Accessories

Water-resistant sealer

Sample warranty

Fire resistance rating

#### SD-04 Samples

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

#### SD-06 Test Reports

Split resistance

Cycle-slam

Hinge loading resistance

Submit split resistance test report for doors tested in accordance with WDMA TM-5, cycle-slam test report for doors tested in accordance with WDMA TM-7, and hinge loading resistance test report for doors tested in accordance with WDMA TM-8.

### 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inches thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Do not store in a building under construction until concrete, masonry work, and the work are dry. Replace defective or damaged doors with new ones.

### 1.4 WARRANTY

Warranty shall warrant doors free of defects for the "life of the installation."

## PART 2 PRODUCTS

### 2.1 DOORS

Provide doors of the types, sizes, and designs indicated and specified.

### 2.1.1 Flush Doors

Flush doors shall conform to WDMA I.S. 1-A. Stile edge bands of doors to receive natural finish shall be hardwood, compatible with face veneer. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware.

#### 2.1.1.1 Interior Flush Doors

Provide staved lumber or particleboard core, Type II flush doors conforming to WDMA I.S. 1-A with faces of premium grade select red birch. Hardwood veneers shall be rotary cut and book matched.

### 2.1.2 Composite-Type Fire Doors

Doors specified or indicated to have a fire resistance rating shall conform to the requirements of UL 10B, ASTM E 152, or NFPA 252 for the class of door indicated. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

## 2.2 ACCESSORIES

### 2.2.1 Door Light Openings

Provide glazed openings with wood moldings of the same specie and color as the face veneers. Moldings for flush doors shall be lip type. Provide glazed openings in fire-rated doors with fire rated frames. Glazing is specified in Section 08810A, "Glass and Glazing."

### 2.2.2 Additional Hardware Reinforcement

Provide fire rated doors with hardware reinforcement blocking. Size of lock blocks shall be as required to secure the hardware specified. Top, bottom and intermediate rail blocks shall measure 5 inches minimum by full core width. Reinforcement blocking shall be in compliance with the manufacturer's labeling requirements and shall not be mineral material similar to the core.

## 2.3 FABRICATION

### 2.3.1 Marking

Each door shall bear a stamp, brand, or other identifying mark indicating quality and construction of the door.

### 2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based.

### 2.3.3 Adhesives and Bonds

WDMA I.S. 1-A. Use Type II bond for interior doors. Adhesive for doors to receive a natural finish shall be nonstaining.

### 2.3.4 Prefitting

At the Contractor's option, doors may be provided factory pre-fit. Doors shall be sized and machined at the factory by the door manufacturer in



accordance with the standards under which they are produced. The work shall include sizing, beveling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules as required to coordinate the work.

#### 2.3.5 Factory Finish

Provide doors finished at the factory by the door manufacturer with a clear finish as follows: AWI Qual Stds Section 1500, specification for System No. 4 Conversion varnish alkyd urea or System No. 5 Vinyl catalyzed. The coating shall be AWI Qual Stds premium, medium rubbed sheen, closed grain effect. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are scratched or marred, or where exposed fastener holes are filled, in accordance with the door manufacturer's instructions. Match color and sheen of factory finish using materials compatible for field application.

#### 2.3.6 Water-Resistant Sealer

Provide a water-resistant sealer compatible with the specified finish as approved and as recommended by the door manufacturer.

#### 2.4 SOURCE QUALITY CONTROL

Styles of "B" and "C" label fire doors utilizing standard mortise leaf hinges shall meet the following performance criteria:

- a. Split resistance: Average of ten test samples shall be not less than 500 pounds load when tested in accordance with WDMA TM-5.
- b. Cycle-slam: 200,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of WDMA TM-7.
- c. Hinge loading resistance: Average of ten test samples shall be not less than 700 pounds load when tested for direct screw withdrawal in accordance with WDMA TM-8 using a No. 12, 1 1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1 1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inches. Door warp shall not exceed 1/4 inch when measured in accordance with WDMA I.S. 1-A.

3.1.1 Fire Doors

Install fire doors in accordance with NFPA 80. Do not paint over labels.

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SECTION 08331A

METAL ROLLING COUNTER DOORS

09/98

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## SECTION 08331A

## METAL ROLLING COUNTER DOORS

09/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M (1999a) Steel Sheet, Zinc-Coated  
(Galvanized) or Zinc-Iron Alloy-Coated  
(Galvannealed) by the Hot-Dip Process

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1999) Fire Doors and Fire Windows

## 1.2 GENERAL

Rolling counter doors shall be of the type, size, and design indicated on the drawings, and shall be the standard product of a manufacturer regularly engaged in the production of rolling counter doors. Each door shall be provided with a permanent label showing the manufacturer's name and address and the model number of the door.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Approved Detail Drawings

Drawings showing elevations of each door type, details of anchorage, details of construction, location and description of hardware, shape and thickness of materials, details of joints and connections, and details of guides and fittings. A schedule showing the location of each counter door shall be included with the drawings.

## SD-03 Product Data

## Rolling Counter Doors

Manufacturer's descriptive data and catalog cuts.

## SD-10 Operation and Maintenance Data

Metal Rolling Counter Doors, Data Package 1; G, RE  
Power Operators, Data Package 5; G, RE

Submit data packages in accordance with Section 01781 OPERATION  
AND MAINTENANCE DATA.

## 1.4 DELIVERY AND STORAGE

Rolling counter doors shall be delivered to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Rolling counter doors shall be stored in accordance with the manufacturer's instructions in a dry location that is adequately ventilated and free from dust, water, or other contaminants, and in a manner that permits easy access for inspecting and handling. Doors shall be handled carefully to prevent damage. Damaged items that cannot be restored to like-new condition shall be replaced.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

## 2.1 BASIC COMPONENTS

## 2.1.1 Curtain

The curtain shall be fabricated of galvanized steel slats conforming to ASTM A 653/A 653M, Coating Designation G60 as specified. Thickness of slat material shall be as required by width of opening but not less than 22 gage. Slats shall be approximately 1-1/4 to 1-1/2 inch wide with a depth of crown of 1/2 inch. Alternate slats shall be fitted with end locks to maintain curtain alignment. Bottom of curtain shall be provided with angle or tubular bar reinforcement matching the curtain, and fitted with a resilient bottom seal.

## 2.1.2 Jamb Guides

Guides shall be of 13 gauge minimum thickness galvanized steel angles conforming to ASTM A 653/A 653M, Coating Designation G60.

## 2.1.3 Counterbalance Shaft Assembly

The curtain shall be coiled around a steel tube of sufficient thickness and diameter to prevent deflection exceeding 0.03 inch per foot. The barrel shall contain oil tempered helical steel torsion springs capable of sufficient torque to counterbalance the weight of the curtain. Springs shall be calculated to provide a minimum of 7,500 operating cycles (one complete cycle of door operation will begin with the door in the closed position, move to the full open position and return to the closed position).

## 2.1.4 Brackets

Brackets shall be a minimum 12 gauge thickness steel if flat plate, or 16 gauge thickness if there are a minimum of 3 returns of 3/4 inch width.

#### 2.1.5 Hood

The hood shall be of 24 gauge galvanized steel conforming to ASTM A 653/A 653M, Coating Designation G60.

#### 2.1.6 Locks

The curtain shall be locked at both ends of bottom bar by a chrome-plated mortise cylinder lock keyed into the building keying system. Lock shall be on the room side of the counter door. Keying and cylinder are specified in Section 08710 DOOR HARDWARE

#### 2.1.7 Smoke Control Gasketing

Rolling counter doors shall be provided with perimeter smoke and draft control gasketing.

### 2.2 OPERATION

#### 2.2.1 Power Operators

A high-starting torque, reversible type motor of sufficient power and torque output to move the door in either direction from any position at the required speed shall be furnished. Power operator shall have an emergency push-up operation, limit switch, three-button type control marked "OPEN", "CLOSE", and "STOP". Control voltage shall be 24 vac. Conduit and wiring necessary for proper operation shall be provided in accordance with Section 16415A ELECTRICAL WORK, INTERIOR.

### 2.3 AUTOMATIC CLOSING DEVICE

Counter doors shall be equipped with an automatic closing device which shall operate upon activation of the building's fire alarm system. Fire and smoke doors shall be easily reset by the facility user after they have been released by the detection system. Resetting the door shall not require the use of special tools nor disassembly of any components.

### 2.4 FINISH

Exposed parts of the counter door, including the curtain, bottom rail, guides, and hood shall be of uniform finish and appearance. Galvanized steel shall have a prime coat.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

### 3.2 FIELD FINISHING

Doors shall be field finished in accordance with Section 09900 PAINTS AND COATINGS.

### 3.3 TESTS

Doors shall be drop tested in accordance with NFPA 80 to show proper operation and full automatic closure and shall be reset in accordance with the manufacturer's instructions. A written record of initial test shall be provided to the Contracting Officer.

-- End of Section --

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## SECTION 08710

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**02/02**

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## SECTION 08710

## DOOR HARDWARE

**02/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
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## BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1	(1997) Butts and Hinges (BHMA 101)
BHMA A156.2	(1996) Bored and Preamsembled Locks and Latches (BHMA 601)
BHMA A156.3	(1994) Exit Devices (BHMA 701)
BHMA A156.4	(1992) Door Controls - Closers (BHMA 301)
BHMA A156.5	(1992) Auxiliary Locks & Associated Products (BHMA 501)
BHMA A156.6	(1994) Architectural Door Trim (BHMA 1001)
BHMA A156.7	(1997) Template Hinge Dimensions
BHMA A156.8	(1994) Door Controls - Overhead Holders (BHMA 311)
BHMA A156.16	(1997) Auxiliary Hardware
BHMA A156.18	(1993) Materials and Finishes (BHMA 1301)
BHMA A156.21	(1996) Thresholds
BHMA A156.22	(1996) Door Gasketing Systems

## FEDERAL SPECIFICATIONS (FS)

FF-L-2740A	(1989) Locks, Combination
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows
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NFPA 101 (1997) Life Safety Code

STEEL DOOR INSTITUTE (SDOI)

SDI 100 (1991) Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (1999) Building Materials Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Hardware schedule

Keying system

### SD-03 Product Data

Hardware items

### SD-08 Manufacturer's Instructions

Installation

### SD-10 Operation and Maintenance Data

Hardware Schedule items, Data Package 1; G, RE

Submit data package in accordance with Section 01781, "Operation and Maintenance Data."

### SD-11 Closeout Submittals

Key bitting

## 1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hard- ware Item	Quan- tity	Size	Reference Publi- cation Type No.	Finish	Mfr. Name and Catalog No.	Key Con- trol Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designa- tion
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## 1.4 KEY BITTING CHART REQUIREMENTS

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

- a. Complete listing of all keys (AA1, AA2, etc.).
- b. Complete listing of all key cuts (AA1-123456, AA2-123458).
- c. Tabulation showing which key fits which door.
- d. Copy of floor plan showing doors and door numbers.
- e. Listing of 20 percent more key cuts than are presently required in each master system.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, pivots, and closers of one lock, hinge, pivot, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

### 1.5.2 Coordination

Contractor shall coordinate door hardware with all electronic security devices indicated on the security drawings and specified in Division 13 of these specifications to insure proper door operation and compliance with applicable provisions of NFPA 101. Report potential problems in writing to the Contracting Officer. Include proposed solutions.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

## PART 2 PRODUCTS

### 2.1 TEMPLATE HARDWARE

Hardware to be applied to metal or to prefinished doors shall be made to template. Promptly furnish template information or templates to door and frame manufacturers. Template hinges shall conform to BHMA A156.7. Coordinate hardware items to prevent interference with other hardware.

### 2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Such hardware shall bear the label of Underwriters Laboratories, Inc., and be listed in UL Bld Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

### 2.3 HARDWARE ITEMS

Hinges, pivots, locks, latches, exit devices, bolts, and closers shall be clearly and permanently marked with the manufacturer's name or trademark

where it will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

#### 2.3.1 Hinges

BHMA A156.1, 4 1/2 by 4 1/2 inches unless otherwise indicated in the "Hardware Sets" at the end of this section. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

#### 2.3.2 Pivots

BHMA A156.4 and as indicated in the "Hardware Sets" at the end of this section.

#### 2.3.3 Locks and Latches

##### 2.3.3.1 Bored Locks and Latches

BHMA A156.2, Series 4000, Grade 1, extra heavy-duty, key-in-lever.

##### 2.3.3.2 Auxiliary Locks

BHMA A156.5, Grade 1.

##### 2.3.3.3 Push Button Combination Locks

Heavy-duty, mechanical combination lockset with five pushbuttons, standard-sized knobs, 3/4 inch deadlocking latch, 2 3/4 inch backset. Lock shall be operated by pressing two or more of the buttons in unison or individually in the proper sequence. Inside knob shall always operate the latch. Provide a keyed cylinder on the interior to permit setting the combination. Provide a keyed removable-core cylinder on the exterior to permit bypassing the combination. Provide a thumb turn on the interior to activate passage set function, so that outside knob operates latch without using the combination.

##### 2.3.3.4 Dial Combination Locks

Dial operated, bolt type, electromechanical combination lock with an internal self-activating power plant and LCD display, and complying with FF-L-2740A. Manufacturer's reference is Kaba Mas CDX-09 as manufactured by the Kaba Mas Corporation.

#### 2.3.4 Exit Devices

BHMA A156.3, Grade 1. Provide adjustable strikes for rim type devices. Touch bars shall be provided in lieu of conventional crossbars and arms.

#### 2.3.5 Cylinders and Cores

Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Cylinders and cores shall have seven pin tumblers. Cylinders shall be products of one manufacturer. Cores shall match existing system utilized on the Base. Rim cylinders, mortise cylinders, and levers of bored locksets shall have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

### 2.3.6 Keying System

Provide a keying system of the level required by the Government (not less than Grand Master). Provide key cabinet as specified for each building.

### 2.3.7 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

#### 2.3.7.1 Roses

Provide wrought roses on both sides of each door. In addition to meeting test requirements of BHMA A156.2, roses shall be 0.050 inch thick if unreinforced. If reinforced, outer shell shall be 0.035 inch thick and combined thickness shall be 0.070 inch.

#### 2.3.7.2 Lever Handles

Provide lever handles in lieu of knobs for all locks and latches. Levers shall be solid cast brass, bronze, or zinc without plastic inserts or cores. Lever handles shall return to within 1/2 inch of the door face.

### 2.3.8 Keys

Furnish one file key, one duplicate key, and one working key for each key change and for each master and grand master keying system. Furnish one additional working key for each lock of each keyed-alike group. Furnish 4 of each type of master key and 4 control keys for removable cores. Furnish a quantity of key blanks equal to 20 percent of the total number of file keys. Stamp each key with appropriate key control symbol and "U.S. property - Do not duplicate." Do not place room number on keys.

### 2.3.9 Door Bolts

Manual Flush Bolts: BHMA A156.16. Provide dustproof strikes for bottom bolts, except for doors having metal thresholds. Automatic latching flush bolts: BHMA A156.3, Type 27.

### 2.3.10 Closers

BHMA A156.4, Series C02000, Grade 1, heavy duty with PT 4D and 4H. Provide closers with cast-iron housings and forged steel pistons and main arms, all weather fluid, and separate regulation of closing speed, latch speed, and back-check. Provide with brackets, arms, mounting devices, fasteners, full size covers, except at storefront mounting, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty. Closers shall have a maximum projection of 2 1/4 inches to minimize conflicts with adjacent walls.

#### 2.3.10.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

### 2.3.11 Overhead Holders/Stops

BHMA A156.8. Each unit shall be adjustable from 85 to 110 degrees.

### 2.3.12 Door Protection Plates

BHMA A156.6, flat stainless steel.

#### 2.3.12.1 Sizes of Kick Plates

Width for single doors shall be 2 inches less than door width; width for pairs of doors shall be one inch less than door width. Height of kick plates shall be 10 inches for flush doors.

### 2.3.13 Push and Pull Devices

BHMA A156.6.

#### 2.3.13.1 Push Plates

Stainless steel, 4 inches x 16 inches.

#### 2.3.13.2 Pull Plate

Similar to J405 except handle shall be 1 inch round stainless steel rod or tube of constant diameter with mounting legs 8 inches apart o.c. Plate over which handle is mounted shall be stainless steel, 4 inches x 16 inches.

#### 2.3.13.3 Pull Handles

Category J401, aluminum, bronze, or stainless steel, 1 inch to 1-1/4 inches in diameter with mounting legs 8 inches apart o.c. Projection shall be between 2-1/2 and 3 inches.

#### 2.3.13.4 Push Bars

Category J501, aluminum, bronze, or stainless steel, 1 inch to 1-1/4 inches in diameter, and designed to span from stile-to-stile of aluminum doors. Projection shall be between 2-1/2 and 3 inches.

### 2.3.14 Door Silencers

BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

### 2.3.15 Door Stops

Every door shall be provided with a door stop, even though a stop may not be indicated in the Hardware Schedule. Overhead stops as specified hereinbefore are indicated in individual "hardware sets" where required. Wall stops complying with BHMA A156.4, Type L12101 shall be provided typically. If a wall stop is unsuitable because a door swings against a window, chalk/tackboard, coat rack, etc., then a floor stop complying with BHMA A156.4, Type L12141 or L12161 shall be provided. Where a door would conflict with another door, then a roller bumper complying with BHMA A156.4, Type L12191, L12201, or L12211 shall be provided.

### 2.3.16 Thresholds

BHMA A156.21.

### 2.3.17 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". A set shall include head and jamb seals, and sweep strips. Air leakage of weather stripped doors shall not exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283. Weather stripping shall be one of the following:

#### 2.3.17.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Aluminum shall be clear (natural) anodized.

### 2.3.18 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

## 2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Fasteners exposed to weather shall be of nonferrous metal or stainless steel. Provide fasteners of type necessary to accomplish a permanent installation.

## 2.5 FINISHES

BHMA A156.18. Hardware shall have BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except surface door closers which shall have aluminum paint finish, and except interior steel hinges which shall have BHMA 652 finish (satin chromium plated). Hinges for exterior doors shall be stainless steel with BHMA 630 finish or chromium plated brass or bronze with BHMA 626 finish. Exit devices may be provided in BHMA 626 finish in lieu of BHMA 630 finish. Exposed parts of concealed closers shall have finish to match lock and door trim. Hardware for aluminum doors shall be finished to match the doors.

## 2.6 KEY CABINET AND CONTROL SYSTEM

BHMA A156.5, Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.



### 3.1.1 Weather Stripping Installation

Handle and install weather stripping so as to prevent damage. Provide full contact, weather-tight seals. Doors shall operate without binding.

#### 3.1.1.1 Stop-Applied Weather Stripping

Fasten in place with color-matched sheet metal screws not more than 9 inches o.c. after doors and frames have been finish painted.

### 3.1.2 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

## 3.2 FIRE DOORS AND EXIT DOORS

Install hardware in accordance with NFPA 80 for fire doors, NFPA 101 for exit doors.

## 3.3 HARDWARE LOCATIONS

SDI 100, unless indicated or specified otherwise.

- a. Kick Plates: Push side of single-acting doors.

## 3.4 KEY CABINET AND CONTROL SYSTEM

Locate where directed. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key.

Furnish complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

## 3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

## 3.6 HARDWARE SETS

### 3.6.1 Interior Hardware Sets

#### HW-1

- 1 1/2 Pr. Hinges A8133
- 1 Ea. Privacy Lock F76
- 1 Ea. Door Stop as specified.

#### HW-2

1 1/2 Pr. Hinges A8133  
1 Ea. Classroom Lock F84  
1 Ea. Door Stop as specified.

HW-3

1 1/2 Pr. Hinges A8112  
1 Ea. Push Button Combination Lock as specified.  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as specified.

HW-4

1 1/2 Pr. Hinges A8133  
1 Ea. Push Button Combination Lock as specified.  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-5

1 1/2 Pr. Hinges A8112  
1 Ea. Push Plate J301  
1 Ea. Pull Plate J405  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

HW-6

1 1/2 Pr. Hinges A8111 x NRP  
1 Ea. Classroom Lock F84  
1 Ea. Closer C02021  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-7

1 1/2 Pr. Hinges A8112  
1 Ea. Classroom Lock F84  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

See Security Drawings for magnetic switches as applicable.

HW-8

1 Ea. Mortise Cylinder E09211

All other hardware by wire mesh partition manufacturer.

HW-9

3 Pr. Hinges A8112

1 Ea. Classroom Lock F84 (R.H. Leaf)  
1 Ea. Closer C02021 w/Stop-in-Arm (R.H. Leaf)  
2 Ea. Automatic Flushbolt Type 27 (L.H. Leaf)  
2 Ea. Kick Plate J102

HW-10

1 Ea. Mortise Cylinder E09211

All other hardware by metal rolling counter door manufacturer.

HW-11

3 Pr. Hinges A8112  
2 Ea. Push Plate J301  
2 Ea. Pull Plate J405  
2 Ea. Closer C02021  
2 Ea. Kick Plate J102  
2 Ea. Door Stop as Specified.

HW-12

1 1/2 Pr. Hinges A8112  
1 Ea. Passage Latch F75  
1 Ea. Dial Combination Lock as Specified.  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-13

1 1/2 Pr. Hinges A8112  
1 Ea. Push Plate J301  
1 Ea. Pull Plate J405  
1 Ea. Closer C02021  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

HW-14

1 1/2 Pr. Hinges A8112  
1 Ea. Passage Latch F75  
1 Ea. Closer C02021  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

HW-15

1 1/2 Pr. Hinges A8111  
1 Ea. Passage Latch F75  
1 Ea. Dial Combination Lock as Specified.  
1 Ea. Closer C02011  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-16

1 1/2 Pr. Hinges A8133 x NRP  
1 Ea. Storage Lock F86  
1 Ea. Door Stop as Specified.

HW-17

2 Sets        Top and Bottom Offset Pivots C07131  
2 Ea.        Intermediate Offset Pivot C07321  
2 Ea.        Push Bar J501  
2 Ea.        Pull Handle J401  
2 Ea.        Closer C05041 w/Built-in Stop

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-18

1 1/2 Pr.    Hinges A8112 x NRP  
1 Ea.        Passage Latch F75  
1 Ea.        Dial Combination Lock as Specified.  
1 Ea.        Closer C02021 w/Stop-in-Arm  
1 Ea.        Kick Plate J102

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-19

1 1/2 Pr.    Hinges A8133 x NRP  
1 Ea.        Lockset F81  
1 Ea.        Door Stop as Specified.

HW-20

1 1/2 Pr.    Hinges A8112  
1 Ea.        Lockset F81  
1 Ea.        Closer C02011  
1 Ea.        Kick Plate J102  
1 Ea.        Door Stop as Specified.

HW-21

1 1/2 Pr.    Hinges A8112  
1 Ea.        Passage Latch F75  
1 Ea.        Closer C02011  
1 Ea.        Kick Plate J102  
1 Ea.        Door Stop as Specified.

HW-22

1 1/2 Pr.    Hinges A8112  
1 Ea.        Passage Latch F75 (exit only - no trim on corridor side)  
1 Ea.        Closer C02011  
1 Ea.        Kick Plate J102  
1 Ea.        Door Stop as Specified.

See Security Drawings for magnetic switches.

HW-23

1 1/2 Pr. Hinges A8111  
1 Ea. Lockset F81  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

See Security Drawings for card access.

HW-24

1 1/2 Pr. Hinges A8111 x NRP  
1 Ea. Passage Latch F75  
1 Ea. Closer C02021  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-25

1 1/2 Pr. Hinges A8111 x NRP  
1 Ea. Classroom Lock F84  
1 Ea. Closer C02021 w/Stop-In-Arm  
1 Ea. Dial Combination Lock as Specified.  
1 Ea. Electric Strike E09321  
1 Ea. Kick Plate J102  
1 Set Head and Jamb Gaskets R3Y265  
1 Ea. Automatic Door Bottom R3Y335

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable. Steel door frame shall be 14 gage. Coordinate electric strike voltage with Security Drawings.

HW-26

1 1/2 Pr. Hinges A8112 x NRP  
1 Ea. Classroom Lock F84  
1 Ea. Dead Bolt E0171  
1 Ea. Closer C02021 w/Stop-In-Arm  
1 Ea. Kick Plate J102

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-27

1 1/2 Pr. Hinges A8111 x NRP  
1 Ea. Passage Latch F75  
1 Ea. Kaba Mas CDX-09 Lock Assembly  
1 Ea. Closer C02021  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-28

1 1/2 Pr. Hinges A8112  
1 Ea. Push Button Combination Lock as Specified.  
1 Ea. Dead Bolt E0171  
1 Ea. Closer C02011  
1 Ea. Kick Plate J102  
1 Ea. Door Stop as Specified.

## 3.6.2 Exterior Hardware Sets

HW-100

3 Pr. Hinges A2111 x NRP  
1 Ea. Exit Device Type 2, Function 03 w/Cylinder Dogging  
1 Ea. Exit Device Type 3, Function 03 w/Cylinder Dogging  
2 Ea. Closer C02021 w/Stop-in-Arm  
2 Ea. Kick Plate J102  
1 Ea. Door Coordinator Type 21  
1 Ea. Astragal  
1 Ea. Threshold J32100  
1 Set Head and Jamb Gaskets R3Y265  
2 Ea. Door Sweep R3Y435

See Security Drawings for card access, magnetic lock, and magnetic switches as applicable.

HW-101

1 1/2 Pr. Hinges A2111 x NRP  
1 Ea. Storage Lock F86  
1 Ea. Overhead Holder/Stop C11511  
1 Ea. Threshold J35100  
1 Set Head and Jamb Gaskets R3Y265

See Security Drawings for magnetic switches.

HW-102

3 Pr. Hinges A2111, 5" x 4-1/2", NRP  
1 Ea. Storage Lock F86 (R.H.R. Leaf)  
2 Ea. Flushbolt L14081 (L.H.R. Leaf)  
2 Ea. Overhead Holder/Stop C11511  
1 Ea. Surface Applied Astragal (R.H.R. Leaf)  
1 Set Head and Jamb Gaskets R3Y265  
1 Ea. Threshold J35100

See Security Drawings for magnetic switches.

HW-103

2 Sets Top and Bottom Offset Pivots C07131  
2 Ea. Intermediate Offset Pivot C07321  
2 Ea. Exit Device Type 6 or 8, Function 03  
2 Ea. Closer C05041 w/Built-in Stop  
1 Ea. Threshold J32100

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

HW-104

1 1/2 Pr. Hinges A2112 x NRP  
1 Ea. Lockset F81  
1 Ea. Closer C02021 w/Stop-in-Arm  
1 Ea. Kick Plate J102  
1 Ea. Threshold J32100  
1 Set Head and Jamb Gaskets R3Y265  
1 Ea. Door Sweep R3Y435

See Security Drawings for card access, magnetic locks, and magnetic switches as applicable.

-- End of Section --



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SECTION 08810A

GLASS AND GLAZING

05/97

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## SECTION 08810A

GLASS AND GLAZING  
05/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 864	(1999) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1036	(1991; R 1997) Flat Glass
ASTM C 1048	(1997b) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM D 395	(1998) Rubber Property - Compression Set
ASTM E 773	(1997) Accelerated Weathering of Sealed Insulating Glass Units
ASTM E 774	(1997) Classification of the Durability of Sealed Insulating Glass Units
ASTM E 1300	(1998) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

## GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(1997) Glazing Manual
GANA Standards Manual	(1995) Engineering Standards Manual

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1999) Fire Doors and Fire Windows
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NFPA 252

(1995) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

### SD-03 Product Data

#### Insulating Glass Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

### SD-04 Samples

#### Insulating Glass

Two 8 x 10 inch samples of Glass Type 'G1'.

### SD-07 Certificates

#### Insulating Glass

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

## 1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind loading in accordance with ASTM E 1300.

## 1.4 DELIVERY, STORAGE AND HANDLING

Glazing compounds shall be delivered to the site in the manufacturer's unopened containers. Glass shall be stored indoors in a safe, well ventilated dry location in accordance with manufacturer's instructions, and shall not be unpacked until needed for installation. Glass shall not be stored on site over 1 month.

## 1.5 PROJECT/SITE CONDITIONS

Glazing work shall not be started until outdoor temperature is above 40 degrees F and rising, unless procedures recommended by glass manufacturer and approved by Contracting Officer are made to warm the glass and rabbet surfaces. Ventilation shall be provided to prevent condensation of moisture on glazing work during installation. Glazing work shall not be performed during damp or raining weather.

## 1.6 WARRANTY

### 1.6.1 Insulating Glass

Manufacturer shall warrant the insulating glass to be free of fogging or film formation on the internal glass surfaces caused by failure of the hermetic seal for a period of 10 years from Date of Substantial Completion. Warranty shall be signed by manufacturer.

## PART 2 PRODUCTS

### 2.1 FLOAT GLASS

#### 2.1.1 Annealed Glass

Annealed glass shall be Type I transparent flat type, Class 1 - clear, Quality q3 - glazing select, 79 percent light transmittance, 0.81 percent shading coefficient, conforming to ASTM C 1036. Provide as a component of clear laminated glass.

#### 2.1.2 Tinted Glass

Tinted glass shall be Type I transparent flat type, Class 3-tinted, Quality q3 - glazing select, 44 percent light transmittance, and 0.66 percent shading coefficient (before coating), conforming to ASTM C 1036. Color shall be gray. Inside surface shall have an anti-reflective low-emissivity coating. Provide as a component of insulating glass type 'G1'.

### 2.2 ROLLED GLASS

#### 2.2.1 Wired Glass

Wired glass shall be Type II flat type, Class 1 - clear, Quality q8 - glazing, Form 1 - wired and polished both sides, conforming to ASTM C 1036. Wire mesh shall be polished stainless steel Mesh 1 - diamond. Wired glass for fire-rated doors shall be tested as part of a door assembly in accordance with NFPA 252. Provide where wire glass or type 'G4' glass is indicated.

### 2.3 TEMPERED GLASS

Tempered glass shall be kind FT fully tempered transparent flat type, Class 1-clear and 2-tinted, Condition A uncoated surface, Quality q3 - glazing select, 1/4 inch thick, conforming to ASTM C 1048 and GANA Standards Manual.

#### 2.3.1 Clear Tempered Glass

Performance characteristics shall be: Visible light transmittance 89 percent, winter nighttime U-value 1.03, shading coefficient 0.94, and light

to solar gain ratio (LSG) 1.10. Provide where glass type 'G3' is indicated.

#### 2.3.2 Tinted Tempered Glass

Color shall be gray. Inside surface shall have an anti-reflective low-emissivity coating. Performance characteristics (before coating) shall be: Visible light transmittance 44 percent, winter nighttime U-value 1.02, shading coefficient 0.67, and light to solar gain 0.76. Provide as a component of glass type 'G2'.

#### 2.4 LAMINATED GLASS

Laminated glass shall consist of two layers of 1/8 inch thick clear annealed glass as specified hereinbefore. Glass shall be bonded together with 0.030 inch thick PVB interlayer under pressure. Provide as a component of glass type 'G2'.

#### 2.3 INSULATING GLASS

Insulating glass shall be Class A preassembled units of dual-seal construction consisting of lites of glass separated by an aluminum, steel, or stainless steel, spacer and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone. Glass types shall be as follows:

#### 2.5 Low-E Insulating Glass

Interior pane for all insulating units shall be of clear laminated glass as specified hereinbefore. Exterior pane for glass type 'G1' shall be 1/4 inch thick tinted glass as specified hereinbefore. Exterior pane for glass type 'G2' shall be 1/4 inch thick tinted tempered glass as specified hereinbefore. Total thickness shall be one inch with an approximate 1/2 inch air space. Performance characteristics shall be: visible light transmittance 37 percent, winter nighttime U-value 0.35, shading coefficient 0.45, and light to solar gain ratio (LSG) 0.95.

#### 2.6 GLAZING ACCESSORIES

##### 2.6.1 Preformed Tape

Preformed tape shall be elastomeric rubber extruded into a ribbon of a width and thickness suitable for specific application. Tape shall be of type which will remain resilient, have excellent adhesion, and be chemically compatible to glass, metal, or wood.

##### 2.6.2 Sealant

Sealant shall be elastomeric conforming to ASTM C 920, Type S or M, Grade NS, Class 12.5, Use G, of type chemically compatible with setting blocks, preformed sealing tape and sealants used in manufacturing insulating glass. Color of sealant shall be as selected.

##### 2.6.3 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking

projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners.

#### 2.6.3.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

#### 2.6.3.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

#### 2.6.3.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

#### 2.6.4 Setting and Edge Blocking

Neoprene setting blocks shall be dense extruded type conforming to ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer.

### PART 3 EXECUTION

#### 3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA Glazing Manual and glass manufacturer's recommendations including size, squareness, offsets at corners, presence and function of weep system, face and edge clearance requirements and effective sealing between joints of glass-framing members. Detrimental materials shall be removed from glazing rabbet and glass surfaces and wiped dry with solvent. Glazing surfaces shall be dry and free of frost.

#### 3.2 INSTALLATION

Glass and glazing work shall be performed in accordance with approved shop drawings, GANA Glazing Manual, glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire/safety rated glass shall be installed in accordance with NFPA 80. Edges and corners shall not be ground, nipped or cut after leaving factory. Springing, forcing or twisting of units during installation will not be permitted.

#### 3.3 CLEANING

Upon completion of project, outside surfaces of glass shall be washed clean

and the inside surfaces of glass shall be washed and polished in accordance with glass manufacturer's recommendations.

#### 3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

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SECTION 09100N

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09/99

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-- End of Section Table of Contents --



## SECTION 09100N

## METAL SUPPORT ASSEMBLIES

09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(1997; Rev. A) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C 645	(1998) Nonstructural Steel Framing Members
ASTM C 754	(1997) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Metal support systems

Submit for the erection of metal framing, furring, and ceiling suspension systems. Indicate materials, sizes, thicknesses, and fastenings.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations. Storage area shall permit easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A 653/A 653M, G-60; aluminum coating ASTM A 463/A 463M, T1-25; or a 55-percent aluminum-zinc coating.

#### 2.1.1 Materials for Attachment of Gypsum Wallboard

##### 2.1.1.1 Suspended and Furred Ceiling Systems

ASTM C 645.

##### 2.1.1.2 Nonload-Bearing Wall Framing and Furring

ASTM C 645, but not thinner than 0.0329 inch thickness except where heavier gage studs are indicated on drawings. Stud sizes (web depth) shall be as indicated on the drawings. Exterior wall framing is specified in Section 05400, COLD-FORMED METAL FRAMING.

##### 2.1.1.3 Shaft Wall Framing

ASTM C 645. Provide J-runners, C-H studs, E-studs, or similar alternatives as required, with a minimum thickness of 0.0329 inch, for the assembly of fire rated shaft-walls where indicated on the drawings. Studs are designed for the installation of a shaft-wall liner on one side and gypsum board panel on the opposite side. Stud spacing shall be a maximum of 24 inches o.c.

#### 2.1.2 Expanded Metal Security Mesh

Carbon steel flattened expanded metal, Style 1-1/2 #9F as manufactured by McNichols Company or equal.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Systems for Attachment of Gypsum Wallboard

##### 3.1.1.1 Suspended and Furred Ceiling Systems

ASTM C 754, except that furring channels shall be 16 inches o.c. minimum and main runner channels shall not exceed 48 inches o.c.

##### 3.1.1.2 Nonload-Bearing Wall Framing and Furring

ASTM C 754, except as follows and indicated otherwise.

- a. Stud and furring spacing shall not exceed 16 inches o.c.
- b. Frame openings as shown on drawings.
- c. Extend framing to underside of deck above where indicated on drawings.
- d. Brace framing laterally as shown on drawings.

### 3.1.1.3 Shaft-Wall Assemblies

Secure J-runners and E-studs to the walls, floors, and decks above. C-H studs shall be installed in a progressive fashion, as successive liner panels are installed.

### 3.1.2 Security Mesh

Weld to each 16 gage steel stud at 6 inches o.c. and to runner tracks at 6 inches o.c.

## 3.2 ERECTION TOLERANCES

Framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/4 inch in 8 feet from a straight line;
- c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/8 inch in 8 feet from a straight line;
- c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

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## SECTION 09250

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11/01

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-- End of Section Table of Contents --

## SECTION 09250

## GYPSUM BOARD

**11/01**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11 (1992) Interior Installation of  
Cementitious Backer Units

ANSI A108.1 (1992) Cementitious Backer Units

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 36/C 36M (1999) Gypsum Wallboard

ASTM C 79/C 79M (2001) Standard Specification for Treated  
Core and Nontreated Core Gypsum Sheathing  
Board

ASTM C 442/C 442M (1999; Rev. A) Gypsum Backing Board and  
Coreboard

ASTM C 475 (1994) Joint Compound and Joint Tape for  
Finishing Gypsum Board

ASTM C 630/C 630M (2001) Water-Resistant Gypsum Backing Board

ASTM C 840 (2001) Application and Finishing of Gypsum  
Board

ASTM C 954 (2000) Steel Drill Screws for the  
Application of Gypsum Board or Metal  
Plaster Bases to Steel Studs from 0.033  
in. (0.84 mm) to 0.112 in. (2.84 mm) in  
Thickness

ASTM C 1002 (2000) Steel Drill Screws for the  
Application of Gypsum Panel Products or  
Metal Plaster Bases

ASTM C 1047 (1999) Accessories for Gypsum Wallboard  
and Gypsum Veneer Base

ASTM C 1177/C 1177M (1999) Standard Specification for Glass  
Mat Gypsum Substrate for use as Sheathing

ASTM C 1178/C 1178M (1999) Glass Mat Water-Resistant Gypsum

## Backing Board

ASTM C 1396/C 1396M	(2000) Standard Specification for Gypsum Board
ASTM D 226	(1997) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 412	(1998) Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
ASTM D 624	(2000) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1149	(1999) Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber

## GYPSUM ASSOCIATION (GA)

GA 214	(1996) Recommended Levels of Gypsum Board Finish
GA 216	(2000) Application and Finishing of Gypsum Board
GA 253	(1999) Application of Gypsum Sheathing
GA 600	(2000) Fire Resistance and Sound Control Design Manual

## UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(2000) Fire Resistance Directory
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Cementitious backer units

Glass Mat Water-Resistant Gypsum Tile Backing Board

Water-Resistant Gypsum Backing Board

Glass Mat Covered or Reinforced Gypsum Sheathing

Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

### Accessories

Submit for each type of gypsum board and for cementitious backer units.

### SD-07 Certificates

#### Asbestos Free Materials

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

### 1.3.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation.

### 1.3.3 Handling

Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

## 1.4 ENVIRONMENTAL CONDITIONS

### 1.4.1 Temperature

Maintain a uniform temperature of not less than 50 degrees F in the structure for at least 48 hours prior to, during, and following the application of gypsum board, cementitious backer units, and joint treatment materials, or the bonding of adhesives.

### 1.4.2 Exposure to Weather

Protect gypsum board and cementitious backer unit products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

## 1.5 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of 5 years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of 3 years of documented successful experience.



## PART 2 PRODUCTS

## 2.1 MATERIALS

Conform to specifications, standards and requirements specified herein. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

## 2.1.1 Gypsum Board

ASTM C 36/C 36M and ASTM C 1396/C 1396M.

## 2.1.1.1 Regular

48 inches wide, 5/8 inch thick, tapered and featured edges.

## 2.1.1.2 Type X (Special Fire-Resistant)

48 inches wide, 5/8 inch thick, tapered and featured edges.

## 2.1.2 Regular Water-Resistant Gypsum Backing Board

ASTM C 630/C 630M

## 2.1.2.1 Regular

48 inches wide, 5/8 inch thick, tapered edges.

## 2.1.2.2 Type X (Special Fire-Resistant)

48 inches wide, 5/8 inch thick, tapered edges.

## 2.1.3 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C 1178/C 1178M

## 2.1.3.1 Regular

48 inches wide, 5/8 inch thick, square edges.

## 2.1.3.2 Type X (Special Fire-Resistant)

48 inches wide, 5/8 inch thick, square edges.

## 2.1.4 Glass Mat Covered or Reinforced Gypsum Sheathing

Exceeds physical properties of ASTM C 79/C 79M and ASTM C 1177/C 1177M. Provide 1/2 inch, gypsum sheathing. Gypsum board shall consist of a noncombustible water-resistant core, with a glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Gypsum sheathing board shall be warranted for at least 6 months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. All joints, seams and penetrations shall be sealed with compatible sealant.

## 2.1.4.1 Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Sealant shall be compatible with gypsum sheathing, rubber washers for

masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Sealants for gypsum sheathing board edge seams and veneer anchor penetrations shall be the type recommended by the gypsum sheathing manufacturer and have the following performance requirements:

- a. ASTM D 412: Tensile Strength - 80 psi
- b. ASTM D 412: Ultimate Tensile Strength (maximum elongation) - 170 psi
- c. ASTM D 624: Tear Strength, dieB, - 27 ppi
- d. ASTM D 1149: Joint Movement Capability after 14 Days cure - percent  $\pm$  50

#### 2.1.5 Cementitious Backer Units

ANSI A108.1.

#### 2.1.6 Joint Treatment Materials

ASTM C 475.

##### 2.1.6.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

##### 2.1.6.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

##### 2.1.6.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

##### 2.1.6.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

##### 2.1.6.5 Joint Tape

Cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

#### 2.1.7 Fasteners

##### 2.1.7.1 Screws

ASTM C 1002, Type "S" steel drill screws for fastening gypsum board to steel framing members less than 0.033 inch thick. ASTM C 954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

#### 2.1.8 Shaftwall Liner Panel

ASTM C 442/C 442M. Shaftwall liner panel shall conform to UL Fire Resist Dir for the Design Number(s) indicated. Liner Panel shall be specifically manufactured for cavity shaftwall system, with water-resistant paper faces,

bevel edges, single lengths to fit required conditions, one inch thick, by 24 inches wide.

#### 2.1.9 Accessories

ASTM C 1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

#### 2.1.10 Asphalt Impregnated Building Felt

The moisture barrier over gypsum sheathing shall be 15-lb asphalt impregnated felt conforming to ASTM D 226 Type I (No. 15).

#### 2.1.11 Water

Clean, fresh, and potable.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

##### 3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and cementitious backer units.

#### 3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C 840 or GA 216 and the requirements specified herein. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length. Cut out gypsum board as required to make neat close joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

##### 3.2.1 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C 840, System VIII or GA 216.

##### 3.2.2 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

In dry areas (areas other than shower enclosures), apply glass matt water-resistant gypsum tile backing board or water-resistant gypsum backing board in accordance with ASTM C 840, System X or GA 216.

### 3.2.3 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply gypsum sheathing in accordance to gypsum association publication GA 253. Design details for joints and fasteners shall follow gypsum sheathing manufacturer's requirements and be properly installed to protect the substrate from moisture intrusion. Exposed surfaces of the gypsum sheathing shall not be left exposed beyond the manufacture's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 6 inches. Openings shall be properly flashed. All joints, seams and penetrations shall be sealed with compatible silicone sealant.

### 3.2.4 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C 840, System XIII or GA 216, unless indicated otherwise. Control joints between studs in fire-rated construction shall be filled with firestopping to match the fire-rating of construction.

## 3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

### 3.3.1 Application

In wet areas (shower enclosures), apply cementitious backer units in accordance with ANSI A108.11. A 15 lb asphalt impregnated, continuous felt paper membrane shall be placed behind cementitious backer units, between backer units and studs. Membrane shall be placed with a minimum 6 inch overlap of sheets laid shingle style.

### 3.3.2 Joint Treatment

ANSI A108.11.

## 3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C 840, GA 214 and GA 216. Plenum areas above ceilings shall be finished to Level 1 in accordance with GA 214. Water resistant gypsum backing board, ASTM C 630/C 630M, to receive ceramic tile shall be finished to Level 2 in accordance with GA 214. Walls and ceilings without critical lighting to receive flat paints shall be finished to Level 4 in accordance with GA 214. Unless otherwise specified, all gypsum board walls, partitions and ceilings shall be finished to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer.

### 3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

### 3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07900A "Joint Sealing." Apply material with exposed surface flush with gypsum board or cementitious backer units.

#### 3.5.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat.

### 3.6 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resist Dir for the Design Number(s) indicated, or GA 600 for the File Number(s) indicated. Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements. Penetrations through rated partitions and ceilings shall be sealed tight in accordance with tested systems. Fire ratings shall be as indicated.

### 3.7 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finish as specified.

### 3.8 SHAFT WALL FRAMING

The shaft wall system shall be installed in accordance with the system manufacturer's published instructions. Bucks, anchors, blocking and other items placed in or behind shaft wall framing shall be coordinated with electrical and mechanical work. Fireproofing materials which are damaged or removed during shaft wall construction shall be patched or replaced.

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## SECTION 09310

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8/02

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## SECTION 09310

## CERAMIC TILE

8/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |              |  |
|--------------|--|
| ANSI A108.1  | (1999) Installation of Ceramic Tile;<br>including A108.1A-C, 108.4-.13, 118.1-.10,<br>A136.1 |
| ANSI A108.10 | (1999) Installation of Grout in Tilework   |
| ANSI A137.1  | (1988) Ceramic Tile  |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |  |
|-------------|--|
| ASTM A 185  | (1997) Steel Welded Wire Fabric, Plain,<br>for Concrete Reinforcement  |
| ASTM C 33   | (1999a) Concrete Aggregates  |
| ASTM C 144  | (1999) Aggregate for Masonry Mortar  |
| ASTM C 150  | (1999a) Portland Cement  |
| ASTM C 206  | (1984; R 1997) Finishing Hydrated Lime   |
| ASTM C 207  | (1991; R 1997) Hydrated Lime for Masonry<br>Purposes   |
| ASTM C 241  | (1997) Abrasion Resistance of Stone<br>Subjected to Foot Traffic   |
| ASTM C 373  | (1988; R 1994) Water Absorption, Bulk<br>Density, Apparent Porosity, and Apparent<br>Specific Gravity of Fired Whiteware<br>Products |
| ASTM C 648  | (1998) Breaking Strength of Ceramic Tile   |
| ASTM C 847  | (1995) Metal Lath  |
| ASTM C 1027 | (1999) Determining Visible Abrasion<br>Resistance of Glazed Ceramic Tile   |
| ASTM C 1028 | (1996) Determining the Static Coefficient<br>of Friction of Ceramic Tile and Other Like  |



Surfaces by the Horizontal Dynamometer  
Pull-Meter Method

MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual (1991) Design Manual IV Dimensional Stone

TILE COUNCIL OF AMERICA (TCA)

TCA Hdbk (1997) Handbook for Ceramic Tile  
Installation

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tile  
Setting-Bed  
Mortar, Grout, and Adhesive

Manufacturer's catalog data and preprinted installation and cleaning instructions.

SD-04 Samples

Tile  
Marble Thresholds

Samples of sufficient size to show color range, pattern, type and joints.

SD-07 Certificates

Tile  
Mortar, Grout, and Adhesive

Certificates indicating conformance with specified requirements. A master grade certificate shall be furnished for tile.

1.3 DELIVERY AND STORAGE

Materials shall be delivered to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Materials shall be kept dry, protected from weather, and stored under cover in accordance with manufacturer's instructions.

1.4 ENVIRONMENTAL REQUIREMENTS

Ceramic tile work shall not be performed unless the substrate and ambient temperature is at least 50 degrees F and rising. Temperature shall be maintained above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used

they shall be vented to the outside to avoid carbon dioxide damage to new tilework.

#### 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

#### 1.6 EXTRA STOCK

Supply an extra two percent of each type tile used in clean and marked cartons.

### PART 2 PRODUCTS

#### 2.1 TILE

Tile shall be standard grade conforming to ANSI A137.1. Containers shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate. Tile shall be impact resistant with a minimum breaking strength for wall tile of 90 lbs and 250 lbs for floor tile in accordance with ASTM C 648. Water absorption shall be 0.50 maximum percent in accordance with ASTM C 373. Floor tile shall have a minimum coefficient of friction of 0.60 wet and dry in accordance with ASTM C 1028. Floor tile shall be Class IV-Heavy Traffic, durability classification as rated by the manufacturer when tested in accordance with ASTM C 1027 for abrasion resistance as related to foot traffic. Color shall be as indicated in the Finish Schedule on the drawings.

##### 2.1.1 Mosaic Floor Tile

Ceramic mosaic tile and trim shall be unglazed porcelain.

##### 2.1.2 Glazed Wall Tile

Glazed wall tile and trim shall be cushion edged with matte glaze. Tile shall be 4-1/4 x 4-1/4 inches. Provide integral cove base where wall tile occurs; provide top-set cove base elsewhere.

#### 2.2 SETTING-BED

The setting-bed shall be composed of the following:

##### 2.2.1 Aggregate for Concrete Fill

Aggregate shall conform to ASTM C 33. Maximum size of coarse aggregate shall not be greater than one-half the thickness of concrete fill.

##### 2.2.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, white for wall mortar and gray for other uses.

##### 2.2.3 Sand

Sand shall conform to ASTM C 144.

#### 2.2.4 Hydrated Lime

Hydrated lime shall conform to ASTM C 206, Type S or ASTM C 207, Type S.

#### 2.2.5 Metal Lath

Metal lath shall be flat expanded type conforming to ASTM C 847, and weighing not less than 2.5 pounds per square yard.

#### 2.2.6 Reinforcing Wire Fabric

Wire fabric shall conform to ASTM A 185. Wire shall be either 2 x 2 inch mesh, 16/16 wire or 1-1/2 x 2 inch mesh, 16/13 wire.

#### 2.3 WATER

Water shall be potable.

#### 2.4 MORTAR, GROUT, AND ADHESIVE

Mortar, grout, and adhesive shall conform to the following:

##### 2.4.1 Dry-Set Portland Cement Mortar

ANSI A108.1.

##### 2.4.2 Latex-Portland Cement Mortar

ANSI A108.1.

##### 2.4.3 Ceramic Tile Grout

ANSI A108.1; commercial portland cement grout.

##### 2.4.4 Organic Adhesive

ANSI A108.1, Type I.

##### 2.4.5 Cementitious Backer Board

Cementitious backer units, for use as tile substrate over metal studs, shall be in accordance with ANSI A108.1. Cementitious backer units shall be 1/2 inch thick.

#### 2.5 MARBLE THRESHOLDS

Marble thresholds shall be of size required by drawings or conditions. Marble shall be Group A as classified by MIA Design Manual. Marble shall have a fine sand-rubbed finish and shall be white or gray in color as approved by the Contracting Officer. Marble abrasion shall be not less than 12.0 when tested in accordance with ASTM C 241.

#### 2.6 WATERPROOFING MEMBRANE

ANSI A108.10; provide either of the following materials:

##### 2.6.1 Chlorinated-Polyethylene-Sheet

Nonplasticized, chlorinated polyethylene faced on both sides with

high-strength, nonwoven polyester fabric, for adhering to latex-portland cement mortar; 60 inches wide by 0.030 inch nominal thickness.

#### 2.6.2 PVC Sheet

Two layers of PVC sheet heat-fused together and to facings of bondable nonwoven polyester, for adhering to latex-portland cement mortar; 60 inches wide by 0.040 inch nominal thickness

### PART 3 EXECUTION

#### 3.1 PREPARATORY WORK AND WORKMANSHIP

Surface to receive tile shall be inspected and shall conform to the requirements of ANSI A108.1 for surface conditions for the type setting bed specified and for workmanship. Variations of surface to be tiled shall fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Organic Adhesives	1/8 inch in 8 ft.	1/16 inch in 3 ft.
Latex portland cement mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.

#### 3.2 GENERAL INSTALLATION REQUIREMENTS

Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and until membrane waterproofing has been installed and tested. Floor tile installation shall not be started in spaces requiring wall tile until after wall tile has been installed. Tile in colors and patterns indicated shall be applied in the area shown on the drawings. Tile shall be installed with the respective surfaces in true even planes to the elevations and grades shown. Special shapes shall be provided as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Tile bases and coves shall be solidly backed with mortar.

#### 3.3 INSTALLATION OF WALL TILE

Wall tile shall be installed in accordance with the TCA Hdbk, method W242 at gypsum board, method W211 at masonry and method 244 in showers framed with metal studs.

##### 3.3.1 Workable or Cured Mortar Bed (Option)

Tile may be installed over a workable mortar bed or a cured mortar bed in showers framed with metal studs at the option of the Contractor. A 4 mil polyethylene membrane, metal lath, and scratch coat shall also be installed. Workable mortar bed, materials, and installation of tile shall conform to ANSI A108.1. Cured mortar bed and materials shall conform to ANSI A108.1.

##### 3.3.2 Dry-Set Mortar and Latex-Portland Cement Mortar

Dry-set or Latex-portland cement shall be used to install tile over cementitious backer units in accordance with ANSI A108.1.

### 3.3.3 Organic Adhesive

Organic adhesive installation of ceramic tile over water-resistant gypsum wallboard shall conform to ANSI A108.1.

## 3.4 INSTALLATION OF FLOOR TILE

Floor tile shall be installed in accordance with TCA Hdbk, method F121 at depressed slabs and method F113 elsewhere. Shower receptors in showers framed with metal studs shall be installed in accordance with TCA Hdbk, method B414 or B415.

### 3.4.1 Workable or Cured Mortar Bed

Floor tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. Workable mortar bed materials and installation shall conform to ANSI A108.1. Cured mortar bed and materials shall conform to ANSI A108.1.

### 3.4.2 Dry-Set and Latex-Portland Cement

Dry-set or Latex-portland cement mortar shall be used to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI A108.1. Latex portland cement shall be used when installing porcelain ceramic tile.

### 3.4.3 Ceramic Tile Grout

Ceramic Tile grout shall be prepared and installed in accordance with ANSI A108.1.

### 3.4.4 Waterproofing

Install and test for leaks prior to covering with ceramic tile.

### 3.4.5 Concrete Fill

Concrete fill shall be composed by volume of 1 part portland cement to 3 parts fine aggregate to 4 parts coarse aggregate, and mixed with water to as dry a consistency as practicable. The fill shall be spread, tamped, and screeded to a true plane, and pitched to drains or leveled as shown. Concrete fill shall be thoroughly damp cured before application of setting-bed material. Concrete fill shall be reinforced with one layer of reinforcement, with the uncut edges lapped the width of one mesh and the cut ends and edges lapped not less than 2 inches. Laps shall be tied together with 18 gauge wire every 10 inches along the finished edges and every 6 inches along the cut ends and edges. The reinforcement shall be supported and secured in the centers of concrete fills. The mesh shall be continuous; except where expansion joints occur, mesh shall be cut and discontinued across such joints. Reinforced concrete fill shall be provided under the setting-bed where the distance between the under-floor surface and the finished tile floor surface is 2 inches or greater, and shall be of such thickness that the mortar setting-bed over the concrete fill shall be not less nor more than the thickness required in the specified TCA Hdbk methods.

## 3.5 INSTALLATION OF MARBLE THRESHOLDS

Thresholds shall be installed where indicated in a manner similar to that

of the ceramic tile floor. Thresholds shall be the full width of the opening. Head joints at ends shall not exceed 1/4 inch in width and shall be grouted full as specified for ceramic tile.

### 3.6 EXPANSION JOINTS

Joints shall be formed as indicated and sealed as specified in Section 07900A JOINT SEALING.

#### 3.6.1 Walls

Expansion joints shall be provided at control joints in backing material. Wherever backing material changes, an expansion joint shall be installed to separate the different materials.

#### 3.6.2 Floors

Expansion joints shall be provided over construction joints, control joints, and expansion joints in concrete slabs. Expansion joints shall be provided where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas. Expansion joints shall extend through setting-beds and fill.

### 3.7 CLEANING AND PROTECTING

Upon completion, tile surfaces shall be thoroughly cleaned in accordance with manufacturer's approved cleaning instructions. Acid shall not be used for cleaning glazed tile. Floor tile with factory mixed grout shall be cleaned in accordance with instructions of the grout manufacturer. After the grout has set, tile wall surfaces shall be given a protective coat of a noncorrosive soap or other approved method of protection. Tiled floor areas shall be covered with building paper before foot traffic is permitted over the finished tile floors. Board walkways shall be laid on tiled floors that are to be continuously used as passageways by workmen. Damaged or defective tiles shall be replaced.

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## SECTION 09510

## ACOUSTICAL CEILINGS

07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 641/A 641M	(1998) Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM C 423	(2001) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C 635	(2000) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM C 834	(2000e1) Latex Sealants
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials
ASTM E 580	(2000) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint
ASTM E 795	(2000) Mounting Test Specimens During Sound Absorption Tests
ASTM E 1264	(1998) Acoustical Ceiling Products
ASTM E 1414	(2000a) Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
ASTM E 1477	(1998a) Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

## U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04	(1998) Seismic Design for Buildings
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## UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir

(1999) Fire Resistance Directory (2 Vol.)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Acoustical Units  
Suspension system

Manufacturer's descriptive data, catalog cuts, and installation instructions. Submittals which do not provide adequate data for the product evaluation will be rejected.

## SD-04 Samples

Acoustical Units

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color. Acoustical unit samples are not required if the proposed product is same as manufacturers reference listed in the Finish Schedule.

## SD-06 Test Reports

Fire Resistive Ceilings  
Ceiling Attenuation Class and Test

Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified fire endurance and sound transmission requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resist Dir may be submitted in lieu of test reports.

## SD-07 Certificates

Acoustical Units

Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

## 1.3 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The location and extent of acoustical treatment shall be as shown on the approved detail drawings. Reclamation of mineral fiber acoustical ceiling panels to be removed from the job site shall be in accordance with paragraph RECLAMATION PROCEDURES.

### 1.3.1 Fire Resistive Ceilings

Flame spread of acoustical units shall be 25 or less and smoke development shall be 50 or less when tested in accordance with ASTM E 84.

### 1.3.2 Ceiling Attenuation Class and Test

The ceiling attenuation class (CAC) of the ceiling system shall be 33 when determined in accordance with ASTM E 1414. Provide fixture attenuators over light fixtures and other ceiling penetrations, and provide acoustical blanket insulation adjacent to partitions, as required to achieve the specified CAC. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project.

### 1.3.3 Ceiling Sound Absorption

Determine the NRC in accordance with ASTM C 423 Method of Test.

### 1.3.4 Light Reflectance

Determine light reflectance factor in accordance with ASTM E 1477 Test Method.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

## 1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent shall be maintained for 24 hours before, during, and 24 hours after installation of acoustical units.

## 1.6 SCHEDULING

Interior wet work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

## 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided. Standard performance guarantee or warranty shall contain an agreement to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

## 1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of 5 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

## PART 2 PRODUCTS

### 2.1 ACOUSTICAL UNITS

Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

#### 2.1.1 Units for Exposed-Grid System ACT-1

Classification Type: III (non-asbestos mineral fiber with painted finish), Form 2.

Minimum NRC: 0.55 when tested on mounting Type E-400 of ASTM E 795.

Pattern: CE.

Nominal size: 24 by 24 inches.

Edge detail: Square.

Finish: Factory-applied standard white paint.

Minimum LR coefficient: LR-1, 0.85 or greater.

Weight: 0.70 lbs/s.f.

### 2.2 SUSPENSION SYSTEM

Suspension system shall be a standard direct-hung exposed-grid system with standard width flange, and shall conform to ASTM C 635 for heavy-duty systems (main and cross-runners). Surfaces exposed to view shall be aluminum or steel with a factory-applied white baked-enamel finish. Wall molding shall have a flange of not less than 15/16 inch. Inside and outside corner caps shall be provided. Intersections of suspension members shall be overlapped and stepped. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of 1/360 of span length. Seismic details shall conform to the guidance in TI 809-04 and ASTM E 580.

### 2.3 HANGERS

Hangers and attachment shall support a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

#### 2.3.1 Wires

Wires shall conform to ASTM A 641/A 641M, Class 1, 0.106 inches in diameter.

## 2.4 ACCESS PANELS

Access panel shall be any standard lay-in ceiling panel above which is located any type of mechanical, electrical, or plumbing device that may require manipulation or adjustment after ceiling installation is complete.

a. Identify each ceiling access panel by a number utilizing white identification plates or plastic buttons with contrasting numerals. The plates or buttons shall be of minimum 1 inch diameter and securely attached to one corner of each access unit. Provide a typewritten card framed under glass listing the code identification numbers and corresponding system descriptions listed above. Mount the framed card where directed and furnish a duplicate card to the Contracting Officer. Code identification system shall be as follows:

- 1 Fire detection/alarm system
- 2 Air conditioning controls
- 3 Plumbing system
- 4 Heating and steam systems
- 5 Air conditioning duct system
- 6 Sprinkler system
- 7 Intercommunication system
- 8 Program entertainment
- 9 Telephone junction boxes

## 2.5 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

## 2.6 COLORS AND PATTERNS

Colors and patterns for acoustical units shall be as indicated by manufacturers reference.

## 2.7 ACOUSTICAL SEALANT

Acoustical sealant shall conform to ASTM C 834, nonstaining.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Interior wet work shall be completed and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and approved prior to the start of acoustical ceiling installation. Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space.

Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb.

### 3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

#### 3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, hangers shall be provided at a minimum of four hangers per fixture and located not more than 6 inches from each corner of each fixture. See Section 16415A ELECTRICAL WORK, INTERIOR for additional lighting installation requirements.

#### 3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, countersplaying, or other acceptable means.

### 3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Wall molding shall be secured not more than 3 inches from ends of each length and not more than 16 inches on centers between end fastenings.

### 3.1.3 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, and in true alignment. Acoustical units shall be arranged to comply with the reflected ceiling plans.

### 3.1.4 Caulking

Apply a continuous ribbon of acoustical sealant on vertical web of wall or edge moldings prior to installing moldings. Wipe off excess sealant after installing moldings.

## 3.2 CEILING ACCESS PANELS

Ceiling access panels shall be located directly under the items which require access.

## 3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

-- End of Section --

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## SECTION 09650

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08/02

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## SECTION 09650

## RESILIENT FLOORING

08/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2240	(2002) Rubber Property - Durometer Hardness
ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(2000) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(2001) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1999) Vinyl Composition Floor Tile

## 1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Tile Flooring  
Wall Base  
Adhesive for Vinyl Composition Tile  
Adhesive for Wall Base  
Stair treads and risers

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.



## SD-04 Samples

Tile Flooring  
Wall Base  
Stair treads and risers

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 2-1/2 x 4 inches. Samples are not required if proposed products are same as indicated in Finish Schedule.

## SD-06 Test Reports

Moisture Test

Copies of test reports showing suitability of concrete subfloor for receiving resilient flooring.

## SD-08 Manufacturer's Instructions

Wall base  
Tile Flooring  
Stair treads and risers

Copies of flooring manufacturer's recommended installation procedures.

## SD-10 Operation and Maintenance Data

Data Package 1; G, RE

Data Package in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, brands, stock names, production run, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 70 degrees F for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Do not open containers until materials are to be used, except for inspection to verify compliance with requirements.

## 1.5 ENVIRONMENTAL REQUIREMENTS

a. Areas to receive resilient flooring shall be maintained at a temperature above 70 degrees F and below 100 degrees F for 2 days before application, during application and 2 days after application. A minimum temperature of 55 degrees F shall be maintained thereafter.

b. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

## 1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of

other work which would damage the finished surface of the flooring.

#### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

#### 1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 5 tiles for each 1000 tiles. Extra materials shall be from the same lot as those installed. Extra base material composed of 20 linear feet of each color shall be furnished. All extra materials shall be packaged in original containers, properly marked.

### PART 2 PRODUCTS

#### 2.1 UNDERLAYMENT

Underlayment shall be latex type, as recommended by flooring manufacturer.

#### 2.2 TILE FLOORING

##### 2.2.1 Vinyl-Composition Tile (VCT)

Vinyl-composition tile shall conform to ASTM F 1066, Class 2, (through pattern tile), Composition 1, asbestos-free, and shall be 12 inches square and 1/8 inch thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

##### 2.2.2 Stair Treads and Risers

Treads and risers shall conform to composition rubber compounded from a mixture of synthetic and reclaimed rubber. Overall thickness at treads shall be not less than 1/8 inch. Durometer hardness shall be 90, plus or minus 5, when tested in accordance with ASTM D 2240. Treads to have 80 percent of back and nose sanded by manufacturer to assure good adhesion; provide manufacturer's epoxy filler to completely fill gap between stair and tread nose for all treads. Surface of treads shall be raised stud, rectangle or diamond pattern.

##### 2.2.3 Adhesive for Vinyl Composition Tile

Cutback adhesive for installation of tile over concrete above, on or above grade. Moisture and alkali resistant. Non-asbestos formulated or a latex adhesive recommended by flooring manufacturer.

##### 2.2.4 Adhesive for Wall Base

Adhesive for wall base shall be emulsified acrylic latex; non-flammable.

#### 2.3 STRIPS

##### 2.3.1 Edge

Provide carpet reducer of vinyl and approved by flooring manufacturer. Limit vertical lips in edge strips to 1/4 inch; limit total rise to 1/2 inch.

### 2.3.2 Feature

Feature strips shall be vinyl or rubber, 1 inch wide, and of thickness to match the flooring. Color shall be as indicated.

### 2.3.3 Transition

A vinyl or rubber transition strip tapered to meet abutting material shall be provided as required.

### 2.4 WALL BASE

Base shall be manufacturers standard rubber coved style (installed with carpet and resilient flooring). Base shall be 4 inches high and a minimum 1/8 inch thick. Use flexible base to conform to irregularities in walls, partitions, and floors. Provide premolded corners in matching size, shape, and color for all right-angle inside and outside corners. Provide continuous rolls for field-cutting.

### 2.5 POLISH/FINISH

Polish shall conform to ASTM D 4078. Use flooring manufacturer's standard high-solids finish for shine without buffing; non-flammable; compatible with factory-applied finish; may be buffed or burnished for maximum gloss.

### 2.6 MANUFACTURER'S COLOR AND TEXTURE

Color and texture of each product shall be as indicated by manufacturers references in the Finish Schedule on the drawings. Flooring in continuous area or replacement of damaged flooring in continuous area shall be from same production run with same shade and pattern,

## PART 3 EXECUTION

### 3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

#### 3.1.1 Subfloor Requirements

Provide subfloor as specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.2 Surface Examination

Examine surfaces to receive resilient flooring. Correct conditions which will impair proper installation, including:

- a. Variation in surface level greater than 1/8 inch in 10 feet.
- b. Trowel marks, pits, dents, protrusions.
- c. 1/16 inch wide or wider cracks.
- d. Chalk and dust.

- e. Oil, paint, wax, and other deleterious substances.
- f. Moisture.
- g. Concrete curing agents, paint, and sealers that can inhibit bonding or harm flooring.

### 3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

#### 3.2.1 Concrete Floor

Grind ridges and other uneven surfaces smooth. Cut out and fill cracks 1/16 inch or wider with crack filler. Provide mastic underlayment to fill remaining holes, cracks, and depressions and for smoothing, leveling, or creating a feather edge in accordance with instructions of mastic manufacturer. After cleaning and removal of loose particles, prime chalky or dusty surfaces with primer recommended by flooring manufacturer.

#### 3.2.2 Final Cleaning of Substrate

Clean substrate with broom or vacuum immediately prior to the installation of flooring.

### 3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer or by spreading 6 inch square patch of adhesive in each 150 square foot area to receive sheet vinyl flooring, and allowing it to dry overnight. If latex-based underlayment has been used, test patches shall include areas covered with underlayment. If the set adhesive can be scraped easily from floor surfaces, floor is not sufficiently dry. Repeat test until adhesive adheres properly. When adhesive adheres tightly to floor surface, proceed with installation.

### 3.4 GENERAL APPLICATION REQUIREMENTS

To avoid damage, install flooring after other work in same area has been completed. Apply flooring and accessories in accordance with manufacturer's directions, using experienced workers. Detailed requirements follow:

- a. Adhesives: Do not allow smoking, open flames or other sources of ignition in area where solvent-containing adhesives are being used or spread, after posting conspicuous signs reading "NO SMOKING OR OPEN FLAME".

- b. Flooring: Apply in patterns indicated. Start in center of room or area, and work toward edges. Keep tile lines and joints square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Vary width of edge tiles as necessary to maintain full-size tiles in field, but no edge tile shall be less than one-half full size, except where irregular-shape makes it impossible.
- c. Cutting: Cut flooring edges and scribe to walls and partitions after field flooring has been applied.
- d. Edge Strips: Provide edging strips where flooring terminates at points higher than contiguous finished flooring, except where thresholds are provided. Secure plastic strips with adhesive.

### 3.5 INSTALLATION OF VINYL-COMPOSITION TILE AND SOLID VINYL TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

### 3.6 INSTALLATION OF FEATURE STRIPS

Edge strips shall be secured with adhesive as recommended by the manufacturer. Edge strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided. At doors, locate edge strip under door centerline.

### 3.7 INSTALLATION OF WALL BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

### 3.8 INSTALLATION OF TREADS AND RISERS

Stair treads and risers shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Treads and risers shall cover the full width of the stairs in one continuous piece.

### 3.9 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be dry-cleaned to remove all surplus adhesive. No sooner than 5 days after installation, flooring shall be washed with a nonalkaline cleaning solution, rinsed thoroughly with clear cold water, and, except for rubber stair treads, given two coats of polish in accordance with manufacturers written instructions. Rubber stair treads shall be cleaned and maintained as recommended by the manufacturer.

3.10 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

-- End of Section --

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CARPET

**07/03**

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## SECTION 09680

CARPET  
07/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 16	(1998) Test Method: Colorfastness to Light
AATCC 134	(2001) Test Method: Electrostatic Propensity of Carpets
AATCC 165	(1999) Test Method: Colorfastness to Crocking: Carpets - AATCC Crockmeter Method
AATCC 174	(1998) Antimicrobial Activity Assessment of Carpet

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 418	(1993; R 1997) Pile Yarn Floor Covering Construction
ASTM D 3278	(1996e1) Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM D 5252	(2001) Practice for the Operation of the Hexapod Tumble Drum Tester
ASTM D 5417	(1999) Practice for Operation of the Vettermann Drum Tester
ASTM D 5793	(1995) Standard Test Method for Binding Sites Per Unit Length or Width of Pile Yarn Floor Coverings
ASTM D 5848	(1999) Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Coverings

## CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2002) Commercial Carpet Installation Standard
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## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for
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## Products Containing Recovered Materials

## INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2551 (1981) Machine-made Textile Floor Coverings - Determination of Dimensional Changes Due to the Effect of Varied Water and Heat Conditions (AACHEN Test)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Carpet

Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory.

Surface Preparation  
Installation

Three copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

## Regulatory Requirements

Three copies of report stating that carpet contains recycled materials and/or involvement in a recycling or reuse program. Report shall include percentage of recycled material.

## SD-04 Samples

Carpet  
Molding

a. Carpet: Two "Production Quality" samples 18 x 18 inches of each carpet proposed for use, showing quality, pattern, and color specified.

b. Vinyl or Aluminum Moldings: Two pieces of each type at least 12 inches long.

c. Special Treatment Materials: Two samples showing system and installation method.

## SD-06 Test Reports

## Moisture and Alkalinity Tests

Three copies of test reports of moisture and alkalinity content of concrete slab stating date of test, person conducting the test, and the area tested.

#### SD-07 Certificates

##### Carpet

Certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet and carpet with cushion material conforms to the standards specified.

##### Regulatory Requirements

Report stating that the carpet contains recycled materials and indicating the actual percentage of recycled material.

#### SD-10 Operation and Maintenance Data

##### Carpet

##### Cleaning and Protection

Three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

### 1.3 REGULATORY REQUIREMENTS

Carpet and adhesives shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label or demonstrate compliance with testing criteria and frequencies through independent laboratory test results. Carpet type bearing the label will indicate that the carpet has been tested and meets the criteria of the CRI IAQ Carpet Testing Program, and minimizes the impact on indoor air quality. Contractor shall procure carpet in accordance with 40 CFR 247. Carpet shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Where possible, product shall be purchased locally to reduce emissions of fossil fuels from transporting.

### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Materials shall be stored in a clean, dry, well ventilated area, protected from damage and soiling, and shall be maintained at a temperature above 60 degrees F for 2 days prior to installation.

### 1.5 ENVIRONMENTAL REQUIREMENTS

Areas in which carpeting is to be installed shall be maintained at a temperature above 60 degrees F for 2 days before installation, during installation, and for 2 days after installation. A minimum temperature of 55 degrees F shall be maintained thereafter for the duration of the contract. Traffic or movement of furniture or equipment in carpeted area shall not be permitted for 24 hours after installation. Other work which would damage the carpet shall be completed prior to installation of carpet.

## 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties including minimum ten (10) year wear warranty, two (2) year material and workmanship and ten (10) year tuft bind and delamination.

## 1.7 EXTRA MATERIAL

Extra material from same dye lot consisting of uncut carpet tiles shall be provided for future maintenance. A minimum of 5 percent of total square yards of carpet shall be provided.

## PART 2 PRODUCTS

### 2.1 CARPET

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance. Carpet shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) Label. Carpet type bearing the label will indicate that carpet has been tested and meets the criteria of the CRI Green Label Requirements for Indoor Air Quality Test Criteria.

#### 2.1.1 Physical Characteristics

##### 2.1.1.1 MODULAR TILE CARPET

Carpet shall comply with the following:

- a. Carpet Construction: Tufted.
- b. Type: Modular tile 20 x 20 inches square with 0.15 percent growth/shrink rate in accordance with ISO 2551.
- c. Pile Type: Level tip shear.
- d. Pile Fiber: Commercial 100% branded (federally registered trademark) nylon continuous filament.
- e. Pile Height: Minimum 0.16 inch in accordance with ASTM D 418.
- f. Pile thickness: 0.102 inch.
- g. Gauge: Minimum 1/12 inch in accordance with ASTM D 5793.
- h. Stitches or Rows/Wires: Minimum 9.16 per square inch.
- i. Finished Pile Yarn Weight: Minimum 20 ounces per square yard. This does not include weight of backings. Weight shall be determined in accordance with ASTM D 5848.
- j. Pile Density: Minimum 7129.
- k. Total Thickness: 0.28 inch.

1. Dye Method: Solution dyed.
- m. Backing Materials: Primary backing materials shall be those customarily used and accepted by the trade for type of carpet. Secondary backing to suit project requirements shall be those customarily used and accepted by the trade for type of carpet.

#### 2.1.2 Performance Requirements

- a. ARR (Appearance Retention Rating): Carpet shall be tested and have the minimum 3.5-4.0 (Severe) ARR when tested in accordance with either the ASTM D 5252 (Hexapod) or ASTM D 5417 (Vettermann) test methods using the number of cycles for short and long term tests as specified.
- b. Static Control: Static control shall be provided to permanently control static buildup to less than 3 kV when tested at 20 percent relative humidity and 70 degrees F in accordance with AATCC 134.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 3 pound average force for cut pile.
- d. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC 165 and shall have a Class 4 minimum rating on the AATCC Color Transference Chart for all colors.
- e. Colorfastness to Light: Colorfastness to light shall comply with AATCC 16, Test Option E "Water-Cooled Xenon-Arc Lamp, Continuous Light" and shall have a minimum 4 grey scale rating after 40 hours.
- f. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 2.5 lbs./inch.
- g. Antimicrobial: Nontoxic antimicrobial treatment in accordance with AATCC 174 Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.

#### 2.2 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers for installation of carpet shall be waterproof, nonflammable, meet local air-quality standards, and shall be as required by the carpet manufacturer. Release adhesive for modular tile carpet shall be as recommended by the carpet manufacturer. Adhesives flashpoint shall be minimum 140 degrees F in accordance with ASTM D 3278.

#### 2.3 MOLDING

Vinyl molding shall be heavy-duty and designed for the type of carpet being installed. Floor flange shall be a minimum 2 inches wide. Color shall be as selected by the Contracting Officer.

#### 2.4 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be as indicated in the Finish Schedule on the drawings.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

Carpet shall not be installed on surfaces that are unsuitable and will prevent a proper installation. Holes, cracks, depressions, or rough areas shall be repaired using material recommended by the carpet or adhesive manufacturer. Floor shall be free of any foreign materials and swept broom clean. Before beginning work, subfloor shall be tested with glue and carpet to determine "open time" and bond.

### 3.2 MOISTURE AND ALKALINITY TESTS

Concrete slab shall be tested for moisture content and excessive alkalinity in accordance with CRI 104.

### 3.3 PREPARATION OF CONCRETE SUBFLOOR

Installation of the carpeting shall not commence until concrete substrate is at least 90 days old. The concrete surfaces shall be prepared in accordance with instructions of the carpet manufacturer. Type of concrete sealer, when required, shall be compatible with the carpet.

### 3.4 INSTALLATION

All work shall be performed by installers who are CFI certified (International Certified Floorcovering Installer Association), or manufacturer's approved installers. Installation shall be in accordance with the manufacturer's instructions and CRI 104. Edges of carpet meeting hard surface flooring shall be protected with molding; installation shall be in accordance with the molding manufacturer's instructions. Ventilation, personal protection, and other safety precautions recommended by the manufacturer of the adhesive shall be followed. Ventilation shall continue for at least 72 hours following installation.

#### 3.4.1 Modular Tile Installation

Modular tiles shall be installed with release adhesive and shall be snugly jointed together. Tiles shall be laid in an alternating pattern if the pattern is directional.

### 3.5 CLEANING AND PROTECTION

#### 3.5.1 Cleaning

After installation of the carpet, debris, scraps, and other foreign matter shall be removed. Soiled spots and adhesive shall be removed from the face of the carpet with appropriate spot remover. Protruding face yarn shall be cut off and removed. Carpet shall be vacuumed clean.

#### 3.5.2 Protection

The installed carpet shall be protected from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Traffic shall be restricted for at least 45 hours. Protective covering shall be removed when directed by the Contracting Officer.

### 3.6 REMNANTS

Remnants remaining from the installation, consisting of scrap pieces more than 2/3 of a full width tile, shall be provided. Non-retained scraps shall be removed from site and recycled appropriately.

-- End of Section --

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## SECTION 09900

## PAINTS AND COATINGS

02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100Doc (2001) Documentation of the Threshold  
Limit Values and Biological Exposure  
Indices

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1 Scheme for Identification of Piping Systems

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 523 (1999) Standard Test Method for Specular  
Gloss

ASTM D 2092 (1995) Preparation of Zinc-Coated  
(Galvanized) Steel Surfaces for Painting

## CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.1000 Air Contaminants

## FEDERAL STANDARDS (FED-STD)

FED-STD-313 (Rev. C) Material Safety Data,  
Transportation Data and Disposal Data for  
Hazardous Materials Furnished to  
Government Activities

## MASTER PAINTERS INSTITUTE (MPI)

MPI 4 (2001) Interior/Exterior Latex Block Filler

MPI 11 (2001) Exterior Latex, Semi-Gloss

MPI 23 (2001) Surface Tolerant Metal Primer

MPI 44 Interior Latex, Gloss Level 2

MPI 45 (2001) Interior Primer Sealer

MPI 47 (2001) Interior Alkyd, Semi-Gloss

MPI 50 (2001) Interior Latex Primer Sealer

MPI 57	(2001) Interior Oil Modified Clear Urethane, Satin
MPI 77	(2001) Epoxy Cold Cured, Gloss
MPI 79	(2001) Marine Alkyd Metal Primer
MPI 90	(2001) Interior Wood Stain, Semi-Transparent
MPI 94	(2001) Exterior Alkyd, Semi-Gloss
MPI 95	(2001) Fast Drying Metal Primer
MPI 101	(2001) Cold Curing Epoxy Primer
MPI 107	(2001) Rust Inhibitive Primer (Water-Based)
MPI 110	(2001) Interior/Exterior High Performance Acrylic
MPI 147	(2001) Institutional Low Odor / VOC Interior Latex, Gloss Level 5

## U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(Rev. B) Color Code for Pipelines and for Compressed Gas Cylinders
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## SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SP01-01	(2001) Environmentally Preferable Product Specification for Architectural and Anti-Corrosive Paints
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## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PA 1	(2000) Shop, Field, and Maintenance Painting
SSPC Guide 3	(1995) Safety in Paint Application
SSPC VIS 1	(1989) Visual Standard for Abrasive Blast Cleaned Steel (Standard Reference Photographs)
SSPC VIS 3	(1993) Visual Standard for Power- and Hand-Tool Cleaned Steel (Standard Reference Photographs)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning

SSPC SP 7	(1994) Brush-Off Blast Cleaning
SSPC SP 10	(1994) Near-White Blast Cleaning
SSPC SP 12	(1995) Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultra high-Pressure Water Jetting Prior to Recoating

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

In keeping with the intent of Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition", products certified by SCS as meeting SCS SP01-01 shall be given preferential consideration over registered products. Products that are registered shall be given preferential consideration over products not carrying any EPP designation.

### SD-02 Shop Drawings

Piping identification

Submit color stencil codes

### SD-03 Product Data

Coating

Manufacturer's Technical Data Sheets

### SD-04 Samples

Color

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

### SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings

SD-08 Manufacturer's Instructions

Application instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

SD-10 Operation and Maintenance Data

Coatings

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

1.3 APPLICATOR'S QUALIFICATIONS

1.3.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years. List information by individual and include the following:

- a. Name of individual and proposed position for this work.
- b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

#### 1.4 QUALITY ASSURANCE

##### 1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

###### 1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one quart samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

###### 1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

#### 1.5 REGULATORY REQUIREMENTS

##### 1.5.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

##### 1.5.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of

nonvolatile content.

#### 1.5.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

#### 1.5.4 Asbestos Content

Materials shall not contain asbestos.

#### 1.5.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

#### 1.5.6 Silica

Abrasive blast media shall not contain free crystalline silica.

#### 1.5.7 Human Carcinogens

Materials shall not contain ACGIH 0100Doc and ACGIH 0100Doc confirmed human carcinogens (A1) or suspected human carcinogens (A2).

### 1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

### 1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01525, "Safety Requirements" and in Appendix A of EM 385-1-1. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

#### 1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC Guide 3.

#### 1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.

- b. 29 CFR 1910.1000.
- c. ACGIH 0100Doc, threshold limit values.

## 1.8 ENVIRONMENTAL CONDITIONS

### 1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

## 1.9 COLOR SELECTION

Colors of finish coats shall be as indicated on drawings. Where not indicated, colors shall be selected by the Contracting Officer. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors approximate colors indicated and the product conforms to specified requirements.

Tint each coat progressively darker to enable confirmation of the number of coats.

## 1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

### 1.10.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

- a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.
- b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.
- c. Existing coated surfaces that are damaged during performance of the work.

#### 1.10.1.1 Exterior Painting

Includes new surfaces of the buildings and appurtenances as indicated.

#### 1.10.1.2 Interior Painting

Includes new surfaces of the buildings and appurtenances as indicated. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

- a. Exposed columns, girders, beams, joists, and metal deck; and
- b. Other contiguous surfaces.

#### 1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

- a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.
- b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, elevator shafts and chases.
- c. Steel to be embedded in concrete.
- d. Copper, stainless steel, aluminum, brass, and lead unless indicated otherwise.
- e. Hardware, fittings, and other factory finished items.

#### 1.10.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new surfaces.

- a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.
  - (1) Exposed piping, conduit, and ductwork;
  - (2) Supports, hangers, air grilles, and registers;
  - (3) Miscellaneous metalwork and insulation coverings.
- b. Do not paint the following, unless indicated otherwise:
  - (1) New zinc-coated, aluminum, and copper surfaces under insulation
  - (2) New aluminum jacket on piping
  - (3) New interior ferrous piping under insulation.

##### 1.10.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean the surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat primer per schedules. Shield sprinkler heads with protective covering while painting is in progress. Upon completion of painting, remove protective covering from sprinkler heads. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Provide primed surfaces with the following:

- a. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel applied to a minimum dry film thickness



of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. In lieu of red enamel finish coat, provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals.

- b. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil. Provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals throughout the piping systems.

#### 1.10.4 Exterior Painting of Site Work Items

Field coat the following items:

##### New Surfaces

- a. Pipe bollards

#### 1.10.5 Definitions and Abbreviations

##### 1.10.5.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

##### 1.10.5.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

##### 1.10.5.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendering, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

##### 1.10.5.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

## 1.10.5.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

## 1.10.5.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

## 1.10.5.7 EXT

MPI short term designation for an exterior coating system.

## 1.10.5.8 INT

MPI short term designation for an interior coating system.

## 1.10.5.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

## 1.10.5.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

## 1.10.5.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

## 1.10.5.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D 523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

## 1.10.5.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

## 1.10.5.14 Paint

See Coating definition.

## 1.10.5.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

## 1.10.5.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

## PART 2 PRODUCTS

## 2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

## PART 3 EXECUTION

## 3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

## 3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

## 3.3 PREPARATION OF METAL SURFACES

## 3.3.1 New Ferrous Surfaces

- a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas

That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2 or SSPC SP 3. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

- b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/SSPC SP 12 WJ-3.

### 3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7, SSPC SP 6, and SSPC SP 10. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

### 3.3.3 Galvanized Surfaces

- a. New Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, steam, or non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D 2092, Appendix X2, and remove by one of the methods described therein.

### 3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

- a. Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

## 3.4 PREPARATION OF MASONRY SURFACES

### 3.4.1 Masonry

- a. Curing: Masonry surfaces shall be allowed to cure at least 30 days before painting.
- b. Surface Cleaning: Remove the following deleterious substances.
  - (1) Dirt: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.
  - (2) Loose Particles: Remove by wire brushing.
  - (3) Efflorescence: Remove by scraping or wire brushing followed

by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

- c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.
- d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

#### 3.4.2 Gypsum Board

- a. Surface Cleaning: Gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.
- b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with spackling compound and sand smooth.

### 3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

#### 3.5.1 New Plywood and Wood Surfaces:

- a. Wood surfaces shall be cleaned of foreign matter.  
  
Surface Cleaning: Surfaces shall be free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood.
- b. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter in accordance with ASTM D 4444, Method A, unless otherwise authorized.
- c. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints.

#### 3.5.2 Interior Wood Surfaces, Stain or Natural Finish

Interior wood surfaces to receive stain or natural shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth.

### 3.6 APPLICATION

#### 3.6.1 Coating Application

Painting practices shall comply with applicable federal, state and local

laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. For piping in unfinished spaces, provide primed surfaces with one coat of red alkyd gloss enamel to a minimum dry film thickness of 1.0 mil. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. For piping in finished areas, provide prime surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel. Upon completion of painting, remove protective covering from sprinkler heads.

- a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.
- b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

- c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

### 3.6.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

### 3.6.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

### 3.6.4 Coating Systems

- a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

#### Table

Division 10. Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

Division 4. Interior Concrete Masonry Units Paint Table

Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table

Division 6. Interior Wood Paint Table

Division 9: Interior Gypsum Board Paint Table

- b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.
- c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

### 3.7 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.
- b. Inaccessible Surfaces: Prior to erection, use one coat of

specified primer on metal surfaces that will be inaccessible after erection.

- c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.
- d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.
- e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.
- f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

### 3.8 COATING SYSTEMS FOR CONCRETE MASONRY UNITS

Apply coatings of Tables in Division 4 and 9 for Exterior and Interior.

### 3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD

- a. Apply coatings of Tables in Division 6 Interior.
- b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.
- c. Apply stains in accordance with manufacturer's printed instructions.

### 3.10 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101 or ANSI A13.1. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101 or ANSI A13.1, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

### 3.11 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

### 3.12 PAINT TABLES

All DFT's are minimum values.



## 3.12.1 EXTERIOR PAINT TABLES

## DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

## STEEL / FERROUS SURFACES

- A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

## 1. Alkyd

New; MPI EXT 5.1Q-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
---------	---------------	----------

MPI 23	MPI 94	MPI 94
--------	--------	--------

System DFT: 5.25 mils

## EXTERIOR GALVANIZED SURFACES

- B. New Galvanized surfaces:

## 1. Epoxy Primer / Waterborne Light Industrial Coating

MPI EXT 5.3K-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
---------	---------------	----------

MPI 101	MPI 110-G5	MPI 110-G5
---------	------------	------------

System DFT: 5 mils

- C. Surfaces adjacent to painted surfaces; Mechanical, Electrical, and miscellaneous metal items not otherwise specified except new prefinished equipment. Match surrounding finish:

## 1. Alkyd

MPI EXT 5.1D-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
---------	---------------	----------

MPI 79	MPI 94	MPI 94
--------	--------	--------

System DFT: 5.25 mils

## DIVISION 10: EXTERIOR CLOTH COVERINGS AND BITUMINOUS COATED SURFACES PAINT TABLE

- A. Insulation and surfaces of insulation coverings (canvas, cloth, paper): (Interior and Exterior Applications)

## 1. Latex

MPI EXT 10.1A-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
---------	---------------	----------

N/A	MPI 11	MPI 11
-----	--------	--------

System DFT: 3.2 mils

Topcoat: Coating to match adjacent surfaces.

## 3.12.2 INTERIOR PAINT TABLES

## DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

- A. New Concrete masonry:

## 1. Institutional Low Odor / Low VOC Latex

New; MPI INT 4.2E-G5 (Semigloss)

Filler	Primer:	Intermediate:	Topcoat:
--------	---------	---------------	----------

MPI 4	N/A	MPI 147	MPI 147
-------	-----	---------	---------

## DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

System DFT: 4 mils

## DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

## INTERIOR STEEL / FERROUS SURFACES

A. Metal, Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, surfaces adjacent to painted surfaces (Match surrounding finish), exposed copper piping, and miscellaneous metal items not otherwise specified except new prefinished equipment:

1. Alkyd  
MPI INT 5.1E-G5 (Semigloss)  
Primer: Intermediate: Topcoat:  
MPI 79 MPI 47 MPI 47  
System DFT: 5.25 mils

B. Miscellaneous non-ferrous metal items not otherwise specified except new prefinished equipment. Match surrounding finish:

1. Alkyd  
MPI INT 5.4J-G5 (Semigloss)  
Primer: Intermediate: Topcoat:  
MPI 95 MPI 47 MPI 47  
System DFT: 5 mils

## DIVISION 6: INTERIOR WOOD PAINT TABLE

A. New Wood and plywood not otherwise specified:

1. Alkyd  
MPI INT 6.4B-G5 (Semigloss)  
Primer: Intermediate: Topcoat:  
MPI 45 MPI 47 MPI 47  
System DFT: 4.5 mils

B. New Wood and Plywood, natural finish or stained:

1. Natural finish, oil-modified polyurethane  
New; MPI INT 6.4J-G4  
Primer: Intermediate: Topcoat:  
MPI 57 MPI 57 MPI 57  
System DFT: 4 mils
2. Stained, oil-modified polyurethane  
New; MPI INT 6.4E-G4  
Stain: Primer: Intermediate: Topcoat:  
MPI 90 MPI 57 MPI 57 MPI 57  
System DFT: 4 mils

C. New Wood Doors; Stained:

1. Stained, oil-modified polyurethane  
New; MPI INT 6.3E-G4  
Stain: Primer: Intermediate: Topcoat:  
MPI 90 MPI 57 MPI 57 MPI 57  
System DFT: 4 mils

## DIVISION 6: INTERIOR WOOD PAINT TABLE

Note: Sand between all coats per manufacturers recommendations.

## DIVISION 9: INTERIOR GYPSUM BOARD, PAINT TABLE

## A. New Wallboard indicated as GWP:

## 1. Latex (Ceilings only)

New; MPI INT 9.2A-G2 (Flat)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 44	MPI 44
System DFT: 4 mils		

## 2. Institutional Low Odor / Low VOC Latex

New; MPI INT 9.2M-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 147	MPI 147
System DFT: 4 mils		

## B. New Wallboard indicated in Finish Schedule as GWL:

## 1. Epoxy

New; MPI INT 9.2E-G6 (Gloss)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 77	MPI 77
System DFT: 4 mils		

-- End of Section --

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SECTION 10153

TOILET PARTITIONS

**08/02**

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PART 3 EXECUTION

- 3.1 INSTALLATION
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-- End of Section Table of Contents --

## SECTION 10153

## TOILET PARTITIONS

08/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by basic designation only.

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191 (1998) ADA Accessibility Guidelines for -  
Buildings and Facilities

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003 (Basic) Partitions, Toilet, Complete

## 1.2 SYSTEM DESCRIPTION

Toilet partition system, including toilet enclosures, and urinal screens, shall be a complete and usable system of panels, hardware, and support components. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. The partition system shall be provided by a single manufacturer, and shall be a standard product as shown in the most recent catalog data. The partition system shall be as shown.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Toilet enclosures  
Urinal screens  
Hardware

Drawings showing plans, elevations, details of construction, hardware, reinforcing, fittings, mountings, and anchorings.

## SD-03 Product Data

Toilet enclosures  
Urinal screens  
Hardware

Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

#### SD-04 Samples

Toilet enclosures  
Urinal screens  
Hardware

Manufacturer's standard finish samples.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated; free from dust, water, or other contaminants; and shall have easy access for inspection and handling.

### 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 TOILET ENCLOSURES

Toilet enclosures shall conform to CID A-A-60003, Type I, Style B, ceiling hung. Width, length, and height of toilet enclosures shall be as shown. Finish surface of panels shall be stainless steel, Finish 2. Panels indicated to receive toilet paper holders or grab bars as specified in Section 10800 TOILET ACCESSORIES, shall be reinforced for mounting of the items required. Grab bars shall withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars shall not rotate within their fittings.

### 2.2 URINAL SCREENS

Urinal screens shall conform to CID A-A-60003, Type III, wall hung. Finish surface of screens shall be stainless steel, Finish 2. Width and height of urinal screens shall be as shown. Secure wall hung urinal screens with 42 inch long, continuous stainless steel flanges.

### 2.3 HARDWARE

Hardware for the toilet partition system shall conform to CID A-A-60003 for the specified type and style of partitions. Hardware finish shall be highly resistant to alkalies, urine, and other common toilet room acids. Hardware shall be either stainless steel or chrome-plated non-ferrous alloy. Latching devices and hinges for handicap compartments shall comply with 36 CFR 1191 and shall operate without either tight grasping or twisting of the wrist of the operator.

### 2.4 FINISH

#### 2.4.1 Finish No. 2

Partitions, panels and door finishes shall conform to CID A-A-60003 and

shall be Finish No. 2, stainless steel.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Toilet partitions shall be installed straight and plumb with uniform clearance of 1/2 inch between pilasters and panels; 1 inch between pilasters and walls; and not more than 3/16 inch between pilasters and doors, in accordance with approved manufacturer's instructions with horizontal lines level and rigidly anchored to the supporting construction.

Anchorage to walls shall be by toggle bolting to CMU and screwing to minimum 18 gage (or heavier if indicated on drawings) steel studs. Drilling and cutting for installation of anchors shall be at locations that will be concealed in the finished work. In the finished work, conceal evidence of drilling in walls. Screws and bolts shall be stainless steel.

#### 3.2 ADJUSTING AND CLEANING

Doors shall have a uniform vertical edge clearance of approximately 3/16 inch and shall rest open at approximately 30 degrees when unlatched. Toilet partitions shall be cleaned in accordance with approved manufacturer's instructions and shall be protected from damage until accepted.

-- End of Section --

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SECTION 10201N

METAL WALL LOUVERS

09/99

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## SECTION 10201N

## METAL WALL LOUVERS

09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

- |            |   |
|------------|---|
| AMCA 500-D | (1998) Laboratory Methods of Testing<br>Dampers for Rating          |
| AMCA 511   | (1999; R 2002) Certified Ratings Program<br>for Air Control Devices |

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

- |           |  |
|-----------|--|
| AAMA 2604 | (1992; Addendum 1995) High Performance<br>Organic Coatings on Architectural<br>Extrusions and Panels |
|-----------|--|

## ASTM INTERNATIONAL (ASTM)

- |            |   |
|------------|---|
| ASTM B 209 | (2002a) Aluminum and Aluminum-Alloy Sheet<br>and Plate                                  |
| ASTM B 221 | (2002) Aluminum and Aluminum-Alloy<br>Extruded Bars, Rods, Wire, Profiles, and<br>Tubes |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Wall louvers

Show all information necessary for fabrication and installation of louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

## SD-04 Samples

## Wall louvers

Colors of finishes shall closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

### 1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers shall be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Aluminum Sheet

ASTM B 209, alloy 3003 or 5005 with temper as required for forming.

#### 2.1.2 Extruded Aluminum

ASTM B 221, alloy 6063-T5 or -T52.

### 2.2 METAL WALL LOUVERS

Weather resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-D and AMCA 511. The rating shall show a water penetration of 0.10 or less ounce per square foot of free area at a free velocity of 800 feet per minute. Louver depth and basic blade design shall be as indicated on the drawings.

#### 2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

#### 2.2.2 Mullions

Same material and finish as louvers. Provide exposed and concealed mullions where indicated in the louver schedule on the drawings.

#### 2.2.3 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers. Locate screens on inside face of louvers.

### 2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers. Provide other accessories as required for complete and proper installation.

## 2.4 FINISHES

### 2.4.1 Aluminum

Provide factory-applied organic coating.

#### 2.4.1.1 Organic Coating

Clean and prime exposed aluminum surfaces and apply a high-performance finish conforming to AAMA 2604, 1.2 mil minimum dry film thickness, color as indicated on drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Wall Louvers

Install using flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

#### 3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

### 3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

#### 3.2.1 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

#### 3.2.2 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

#### 3.2.3 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

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SECTION 10440

INTERIOR SIGNAGE

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-- End of Section Table of Contents --

## SECTION 10440

## INTERIOR SIGNAGE

07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (1984; R 1994) Safety Performance  
Specifications and Methods of Test for  
Safety Glazing Materials Used in Buildings

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Detail Drawings

Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

## SD-03 Product Data

## Installation

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

## SD-04 Samples

## Interior Signage

One sample of each of the following sign types showing typical quality and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

- a. Door number sign.

b. Room identification sign.

Two samples of manufacturer's standard color chips for each material requiring color selection.

1.3 GENERAL

Interior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, and related components for a complete installation.

1.3.1 Character Proportions and Heights

Letters and numbers on signs shall be helvetica medium, size as indicated.

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 DOOR NUMBER SIGNS

Signs shall be fabricated of Type ES/MP laminated thermosetting plastic suitable for engraving. Characters shall be engraved into sign surface revealing a white sub-color.

2.2 ROOM IDENTIFICATION SIGNAGE SYSTEM

Signs shall be fabricated of acrylic plastic conforming to ANSI Z97.1.

2.2.1 Standard Room Signs

Signs shall consist of matte finish acrylic plastic. Units shall be frameless. Corners of signs shall have a 1/4 inch radius.

2.2.2 Changeable Message Strip Signs

Changeable message strip signs shall consist of cast acrylic plastic captive message slider sign face with message slots and associated end caps for insertion of changeable message strips. Size of signs shall be as shown on the drawings. Individual message strips to permit removal, change, and reinsertion shall be provided as detailed. Corners of signs shall have a 1/4 inch radius.

2.2.3 Type of Mounting For Signs

Signs shall be surface mounted and shall be provided with vinyl foam tape.

#### 2.2.4 Graphics

Signage graphics for room identification/directional signs shall conform to the following:

- a. Silkscreened text: Silkscreened images shall be executed with photo screens prepared from original art. Handcut screens will not be accepted. Original art shall be defined as artwork that is a first generation reproduction of the specified art. Edges and corners shall be clean.
- b. Raised acrylic text: Acrylic letters 1/8 inch thick and chemically welded to 0.125 inch thick acrylic backup sheet.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the detail drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting location for such signage shall be so that a person may approach within 3 inches of signage without encountering protruding objects or standing within the swing of a door. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

##### 3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions.

Foam tape pads shall be minimum 1/16 inch thick closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 0.005 inch green flatstock treated with silicone. Foam pads shall be sized for the signage as per signage manufacturer's recommendations.

##### 3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

-- End of Section --

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SECTION 10505N

STEEL CLOTHING LOCKERS

09/99

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## SECTION 10505N

## STEEL CLOTHING LOCKERS

09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASTM INTERNATIONAL (ASTM)

ASTM A 366/A 366M (1997e1) Commercial Steel, Sheet,  
Carbon, (0.15 Maximum Percent Cold-Rolled\*\*

ASTM A 569/A 569M (1998) Steel, Carbon (0.15 Maximum  
Percent), Hot-Rolled Sheet and Strip,  
Commercial

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-L-00486 (Rev. J) Lockers, Clothing, Steel

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Types

Location

Installation

Numbering system

## SD-03 Product Data

Material

Finish

Locker components

Assembly instructions

## SD-04 Samples

## Color chips

### 1.3 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

### 1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication.

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Color Chips

Provide a minimum of three color chips, not less than 3 inches square, of each color indicated on the drawings.

## PART 2 PRODUCTS

### 2.1 TYPES

Provide all-welded single tier metal "corridor lockers" in the location, quantities and sizes indicated. Provide locker finish color as indicated.

### 2.2 MATERIAL

#### 2.2.1 JSN Numbers

Lockers are indicated on the drawings by the JSN Numbers A1035M and A1035N.

#### 2.2.2 Locker Classification

Lockers are typically classified in the industry as standard, quiet, corridor, athletic, and open-front athletic. The lockers required by this specification shall be corridor lockers which are similar to standard lockers except they are fabricated from heavier steel sheet and they use all-welded construction.

#### 2.2.3 Steel Sheet

ASTM A 366/A 366M or ASTM A 569/A 569M, commercial quality, minimized spangle material. Prepare material surfaces for baked enamel finishing in accordance with FS AA-L-00486. Minimum uncoated sheet thickness shall be 0.0528 inch unless otherwise indicated.

#### 2.2.4 Finish

FS AA-L-00486.

##### 2.2.4.1 Color

As indicated on drawings.

## 2.3 COMPONENTS

### 2.3.1 Built-In Locks

FS AA-L-00486. Provide a padlock eye in the door latching mechanism.

### 2.3.2 Coat Hooks

FS AA-L-00486, chromium plated.

### 2.3.3 Door Handles

FS AA-L-00486. Provide zinc alloy or steel handles with a chromium coating.

### 2.3.4 Doors

FS AA-L-00486, not less than 0.0677 inch thick steel sheet.

#### 2.3.4.1 Hinges

In addition to the requirements of FS AA-L-00486, provide 5-knuckle hinges, minimum 2 inches high. Fabricate knuckle hinges from not less than 0.0747 inch thick steel sheet. A full height piano hinge may be provided if standard with the manufacturer. Weld or bolt hinges to the door frame. Weld, bolt, or rivet hinges to the door.

#### 2.3.4.2 Latching Mechanisms

FS AA-L-00486.

### 2.3.5 Latch Strikes

FS AA-L-00486. Fabricate from not less than 0.0747 inch thick steel sheet, except latch strike may be continuous from top to bottom and fabricated as part of the door framing.

### 2.3.6 Silencers

FS AA-L-00486.

### 2.3.7 Frames, Side Panels, Tops, and Bottoms

Fabricate from not less than 0.0528 inch thick steel sheet.

### 2.3.8 Backs

Fabricate from not less than 0.0428 inch thick steel sheet.

### 2.3.9 Shelves

Fabricate from not less than 0.0598 inch thick steel sheet. Provide one shelf in each locker.

### 2.3.10 Base Panels

FS AA-L-00486. Provide lockers with closed bases. Fabricate from not less than 0.0528 inch thick steel sheet.

## 2.3.11 Number Plates

FS AA-L-00486. Aluminum. Provide consecutive numbers.

## 2.3.12 Fastening Devices

Provide bolts, nuts, and rivets as specified in FS AA-L-00486.

## PART 3 EXECUTION

## 3.1 ASSEMBLY AND INSTALLATION

Assemble locker groups according to the locker manufacturer's instructions.

Align lockers horizontally and vertically. Secure lockers to base with screws. Bolt adjacent locker groups together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

## 3.2 NUMBERING SYSTEM

Install number plates on lockers consecutively.

## 3.3 FIELD QUALITY CONTROL

## 3.3.1 Testing

Government may request performance-characteristic tests on assembled lockers in accordance with FS AA-L-00486. Lockers not conforming will be rejected.

## 3.3.2 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

## 3.3.3 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

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SECTION 10605

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## SECTION 10605

## WIRE MESH PARTITIONS

09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-973 (1986) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1996) Carbon Structural Steel

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Wire mesh partitions

Show layout, details, materials, dimensions, finishes, and all information necessary for fabrication and installation.

## SD-03 Product Data

Wire mesh partitions

Submit for each type of partition and door.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers or packaging with labels intact and legible. Deliver, store, and handle materials so as to prevent damage. Replace damaged or defective materials with new.

## 1.4 DESCRIPTION OF WORK

Wire mesh partitions shall be all wire type heavy duty for extra heavy industrial use, and shall be provided complete with fasteners, capping bars, adjustable floor sockets, bracing, doors, wire mesh ceilings where indicated, hardware, and other items necessary for a complete, useable, and rigid installation.

## PART 2 PRODUCTS

## 2.1 MATERIALS

## 2.1.1 Steel Shapes, Plates, and Bars

ASTM A 36/A 36M.

## 2.1.2 Cold-Formed Steel

AISI SG-973.

## 2.1.3 Wire Mesh

Carbon steel wire, woven diamond mesh, intermediate crimped.

## 2.1.4 Floor Sockets

Cast or forged steel or ductile iron, adjustable, approximately 2 1/2 inches high.

## 2.2 HEAVY DUTY PARTITIONS

## 2.2.1 Wire Mesh

6 gage wire, 2 inch mesh.

## 2.2.2 Panel Frames

1 1/2 by 3/4 by 1/8 inch steel channels.

## 2.2.3 Center Reinforcing Bar

One 1 1/2 by 3/4 by 1/8 inch channel with all wires woven through, or two 1 1/4 by 3/8 by 1/8 inch channels bolted together with mesh in between.

## 2.2.4 Capping Bar

Structural steel channel, 3 inch by 4.1 pounds.

## 2.2.5 Corner Posts

Structural steel angles, 1 3/4 by 1 3/4 by 1/8 inch.

## 2.2.6 Line Posts

Unless otherwise indicated, provide partitions with flat bar line posts bolted between vertical frame channels. Sizes of posts shall be as follows:

Partition Height	Size of Posts
7 feet to 12 feet	2 1/2 by 5/16 inch

## 2.2.7 Hinged Doors

Frames shall be 1 1/2 by 3/4 by 1/8 inch channels with 1 1/2 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 1 5/8 by 7/8 by 1/8 inch angle riveted to the lock stile. Provide 1 1/2 pairs of heavyweight, wrought steel, non-removable pin, butt hinges riveted or

welded to the door and the door opening frame for each door.

#### 2.2.8 Ceilings

Panels similar to walls and designed to clear span across enclosed space without intermediate support.

#### 2.3 DOOR OPENING FRAMES

Provide frames the same size and shape as the vertical frames for the mesh panels.

#### 2.4 LOCKS

Provide each door with a mortise type lock with a mortise cylinder on the outside and a recessed knob on the inside. Cylinder and keying are specified in Section 08710, DOOR HARDWARE.

#### 2.5 FABRICATION

##### 2.5.1 Standard Panels

Wire shall be woven into diamond mesh, intermediate crimped, and securely clinched to frames. Joints shall be mortised and tenoned. Wire shall be continuous at center reinforcing bars, either woven through a single channel or bolted between two channels. Panel vertical frames shall have 3/8 inch bolt holes 18 inches o.c. for heavy duty partitions.

##### 2.5.2 Doors

Construction shall be similar to that specified for panels. Wire mesh shall be the same as that used in the adjacent partition panels.

##### 2.5.3 Finish

Thoroughly clean ferrous metal, treat with phosphate, and paint with black or gray enamel in the shop.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Wire Mesh Partitions

Install plumb, level, and true to line, within a tolerance of 1/8 inch in 10 feet or the height or run of the partition, if less than 10 feet. Anchor floor sockets to the floor with expansion bolts. Vertical frames and posts shall be bolted together with 3/8 inch bolts 18 inches o.c. for heavy duty partitions. Secure top frames to a continuous capping bar with 1/4 inch diameter U bolts not more than 28 inches o.c. Provide ceilings where indicated on drawings.

##### 3.1.2 Doors

Install in accordance with the manufacturers' recommendations. Adjust as required so that doors and hardware operate freely and properly.



3.1.3 Touch-Up

Clean and paint scratches, abrasions, and other damage to shop painted surfaces to match the shop-applied finish.

-- End of Section --

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SECTION 10650A

OPERABLE PARTITIONS

08/00

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-- End of Section Table of Contents --

## SECTION 10650A

## OPERABLE PARTITIONS

08/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 90	(1999) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
ASTM E 413	(1987; R 1999) Rating Sound Insulation

## 1.2 GENERAL REQUIREMENTS

The Contractor shall supply and install flat wall, manual operation, acoustical operable partitions as shown on the drawings including all hardware, seals, track and rollers as needed to close the specified opening. The partition shall be made up of a series of rigid, flat wall panels; each panel being a one-piece assembly nominally 48 inches wide. Unless otherwise specified, the wall shall comprise the least number of panels. The mechanical seal of the panel shall actuate with a single operating action.

## 1.2.1 Manual Operation

The manual operation shall be accomplished with less than 20 lbf force to start movement at the rate of 3.33 ft/s (200 ft/min). A removable handle shall be used to extend and retract the bottom operable seals; vertical movement of seals shall be 2 inches. Closure to the lead wall shall be by use of a flexible bulb; final closing shall be accomplished by means of a lever exerting pressure against wall.

## 1.3 SUBMITTALS

All items designated with a G, including product literature, calculations, component data, certificates, diagrams and drawings, shall be submitted concurrently in one complete system submittal. Omission of any required submittal item from the package shall be sufficient cause for disapproval of the entire submittal. Unless otherwise indicated in the submittal review commentary, disapproval of any item within the package shall require a re-submittal of the entire system package, in which all deficiencies shall be corrected. Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for

information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Operable Partitions

Drawings containing complete schematic diagrams and details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Operable Partitions

Manufacturer's descriptive data, performance charts, catalog cuts, and installation instructions.

SD-04 Samples

Operable Partitions

Color samples of specified surfaces and finishes to match those specified. Finish and color requirements shall not be limited to manufacturer's standard selections in order to meet these requirements.

SD-07 Certificates

Materials

Operable Partitions

Certificate attesting that the materials meet the requirements specified and that partitions have specified acoustical and flame retardant properties, as determined by test.

SD-10 Operation and Maintenance Data

Data Package 1; G, RE

Data Package in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in the manufacturer's original, unopened packages and shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Door and partition finishes shall have a Class A rating when tested in accordance with ASTM E 84.

#### 2.1.1 Panel Surface Finish

Panel surface finish shall be a vertically-ribbed acoustical synthetic fabric material of 100 percent polyolefin. Pile height shall be minimum 0.098 inch thickness. Color shall match that listed in the Finish Schedule on the drawings.

#### 2.1.2 Hardware

Operable partitions shall have manufacturer's standard hardware. Hardware shall be anodized aluminum with a natural finish, chrome plated or brass plated metal, or painted finish.

#### 2.1.3 Sweep Strips

Sweep strips shall be vinyl or other material which will not crack or craze with severe usage. Sweep strip shall control STC to the specified rating.

#### 2.1.4 Track

Track shall be recessed as shown and shall be of extruded aluminum or enamel finish steel. Track shall be manufacturer's standard product designed for the weight of the finished partition, including door. Track sections shall be provided in the maximum lengths practicable, not less than 6 feet long except for narrow doors and at ends of runs where short length is required. Suitable joint devices such as interlocking keys shall be provided at each joint to provide permanent alignment of track.

#### 2.1.5 Metal Soffit

Soffit shall be provided when steel track is recessed. Soffit shall be of metal of adequate thickness to protect the ceiling from damage by door operation and shall be provided with the door manufacturer's standard neutral-color applied finish. Soffit on aluminum track shall be an integral part of the track.

#### 2.1.6 Vinyl Restrictions

Vinyls shall contain a non-mercury based mildewcide and shall be manufactured without the use of cadmium-based stabilizers.

### 2.2 OPERABLE PARTITIONS

Operable partitions shall consist of top hung ball bearing carriers which support paired modular panels. Partition finish shall have a flame spread rating of not more than 25 in accordance with ASTM E 84.

### 2.2.1 Panels

Panels shall be constructed of minimum 16 gauge thick steel frames with minimum 22 gauge thick face panels spot welded to the frame. Panels shall be not more than 4 feet wide, except for end closure panels, and shall be full height to track. Panels shall lock in place to form a stable, rigid partition; low profile hinges shall project 1/4 inch maximum from panel edge. Panels shall be surfaced with wall carpet which wraps around the vertical panel edges without vertical trim. Panel thickness (4 inch nominal) and composition shall be designed to provide an STC rating of not less than 50 in accordance with ASTM E 90 and ASTM E 413.

### 2.2.2 Seals

Bottom seals shall consist of a vinyl sweep mechanical seal which will expand in place or shall be accomplished by using panels which can be lowered by a removable operating device. Vertical seal between panels shall be anodized, architectural grade, aluminum extrusion with vinyl sound seal.

### 2.3 COLOR

Color shall be as indicated in the Finish Schedule on the drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's approved installation instructions.

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SECTION 10800

TOILET ACCESSORIES

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## SECTION 10800

## TOILET ACCESSORIES

07/02

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Accessory Items

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

## SD-04 Samples

## Accessory Items

One sample of each accessory proposed for use. Approved samples may be incorporated into the finished work, provided they are identified and their locations noted.

## SD-07 Certificates

## Accessory Items

Submit for each type of accessory specified, attesting that the items meet the specified requirements.

## 1.2 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area protected from construction damage and vandalism.

## 1.3 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.



## PART 2 PRODUCTS

## 2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated on the drawings. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

## 2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall have oval heads and shall be finished to match the accessory.

## 2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

Metal	Finish
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, dull

## 2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

## 2.2.1 Item A1066, Mirror, Glass w/S.S. Frame, 18 x 36 Inches

Glass for mirrors shall be Type I transparent flat type, Class 1 - clear. Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

## 2.2.1.1 Frame and Hangers

Mirror frame shall be fabricated from 0.050 inch thick stainless steel channel with corners mitered and mechanically interlocked. Hangers shall be one piece galvanized steel wall-hanger devices with spring-action locking mechanism to hold mirror in position with no exposed screws or bolts.

## 2.2.2 Item A5080, Paper Towel Dispenser

Paper towel dispenser shall be a wall surface mounted unit. Cabinet shall

be approximately 11 inches wide by 15 inches high by 4 inches deep and shall be fabricated from 22 gage, Type 304 stainless steel with a satin finish. Construction shall be welded. Door shall hinge across lower edge on a continuous stainless steel piano hinge and shall have a tumbler lock keyed like all other similar units. Unit shall be capable of dispensing 400 C-fold or 525 multi-fold paper towels without adjustments or adapters. Side slots shall indicate refill status.

#### 2.2.3 Item A5090, Sanitary Napkin and Tampon Disposer

Disposer shall be surface mounted. Container shall be approximately 11 inches wide by 15 inches high by 4 inches deep and shall be fabricated from 22 gage, Type 304 stainless steel with a satin finish. Construction shall be welded. Door shall be self-closing, push flap, sloping type of same material and finish as container and shall be hinged on a continuous stainless steel piano hinge. Waste container shall be constructed of same material as main body. Waste container shall be equipped with key operated latch.

#### 2.2.4 Items A5109 and A5112, Grab Bars

Grab bars shall be fabricated from Type 304, 18 gage stainless steel tubing with a satin finish. Outside diameter of tubing shall be 1-1/4 inches and distance from inside of grab bar to finished wall surface shall be 1-1/2 inches. Ends of tubing shall extend through and be welded to Type 304, stainless steel plate flanges. Flanges shall be 3 inches in diameter and shall have three countersunk screw holes for attachment to walls. Provide Phillips flat head screws of the type and size required for the mounting condition indicated on the drawings. Configuration and size of each grab bar shall be as indicated on the drawings. Installed grab bars shall be capable of withstanding a 250 lb. vertical load at any point without damage. All grab bars shall be provided with concealed 12 gage steel anchor plates.

#### 2.2.5 Item A5135, Rack, Mop/Broom, with Shelf

Mop and broom rack shall consist of 12 inch deep shelf with supporting brackets, drying rod, rag hooks, and mop/broom holders. Length shall be 36 inches. All metal components shall be fabricated from Type 302 stainless steel with a satin finish. Shelf shall be 18 gage with 2 inch return edges. Front edge shall be hemmed. Mounting brackets shall be 16 gage, triangular shaped, and shall be welded to shelf. Provide one bracket within 2 inches of each end of shelf. Provide intermediate brackets spaced equally over the length of the shelf but no farther apart than 24 inches o.c. Intermediate bracket shall not be required on 36 inch long shelves. Mop/broom holders shall be spring loaded rubber cam type and shall be attached to front edge of shelf. Provide one mop/broom holder within 2 inches of each end of shelf. Provide holders spaced equally over the length of the shelf but not farther apart than approximately 10 inches o.c. Rag hooks shall be screw attached or welded to front edge of shelf. Provide one hook in each space between mop/broom holders. Drying rod shall be 1/4 inch diameter and shall be supported by passing through hole in each mounting bracket. Rod shall extend full length of shelf.

#### 2.2.6 Item A5170, Shower Curtain Rods

Shower curtain rod shall be fabricated from 20 gage, Type 304 stainless steel tubing with satin finish. Outside diameter shall be one inch and length shall be as required. Provide two wall flanges for each rod.

Flanges shall be 3 inch diameter by 1/8 inch thick, one piece, die formed, Type 304 stainless steel with satin finish. Provide three holes in each flange for mounting screws. Provide 12 shower curtain hooks with each rod. Hooks shall be fabricated from 0.09 inch diameter stainless steel rod. Hooks shall be sized for use with one inch diameter curtain rods. Hooks shall snap open for placement on curtain rods.

#### 2.2.7 Item A5195, Toilet Paper Holder, Single Roll

Surface mounted single roll toilet tissue dispenser consisting of a one piece heavy-duty cast aluminum base unit with slotted holes for mounting to wall. Base unit shall receive a molded plastic theft resistant spindle without controlled delivery. Size to hold roll up to 5-1/2 inches in diameter.

#### 2.2.8 Item A5205, Bar, Towel

One inch diameter 18 gage stainless steel tube, 24 inches long and supported on each end by heavy cast brass chrome-plated wall brackets with round predrilled flanges for wall mounting and set screws to keep tube from turning.

#### 2.2.9 Item A5075, Soap Dispenser

Soap dispense shall be surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Surfaces of fastening devices exposed after installation shall have the same finish as the attached accessory. Exposed screw heads shall be oval. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. Brackets, plates, anchoring devices and similar items used for mounting accessories in showers shall be bedded in a silicone or polysulphide sealant or a sealant as specified in Section as they are set to provide a watertight installation. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

##### 3.1.1 Recessed Accessories

Fasten accessories to metal studs or framing with sheet metal screws in metal construction.

##### 3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Accessories without backplates shall have concealed fasteners. Unless indicated or specified otherwise, install accessories with sheet metal screws or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner. Fasten accessories mounted on

gypsum board walls without solid backing into the metal studs or to metal backplates secured to metal studs.

### 3.2 CLEANING

Material shall be cleaned in accordance with manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring of surfaces.

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SECTION 10902

TA-50 STORAGE LOCKERS

10/97

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## SECTION 10902

TA-50 STORAGE LOCKERS  
10/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 446	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 525	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Lockers

Detail drawings indicating locker layout, materials, member size, thickness, gauge, hardware, fasteners and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instruction.

## 1.3 GENERAL DESCRIPTION

TA-50 storage lockers shall be single or double tier lockers as indicated on the drawings meeting the following minimum specifications. Lockers shall be sized as shown on the drawings. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 446, or ASTM A 525, as applicable. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Thickness of metal and details of assembly and supports shall provide strength and stiffness.

#### 1.4 WORKMANSHIP

Drilling and punching shall produce clean true lines and surfaces. Exposed surfaces of work in place shall have a smooth finish. Corner joints shall be well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

#### 1.5 ANCHORAGE

Anchorage shall be provided for fastening lockers securely in place. Anchorage to concrete shall be as recommended by the locker manufacturer.

### PART 2 PRODUCTS

#### 2.1 LOCKERS

Lockers shall be heavy duty, all welded ventilated type. Locker units shall be welded at all seams and joints with all exposed welds sanded smooth. There shall be no bolts, rivets or screws used in the construction of the main locker unit.

##### 2.1.1 Tops, Bottoms, Shelves, and Tier Dividers

All tops, bottoms, shelves, and tier dividers shall be constructed of minimum thick cold rolled sheet steel.

##### 2.1.2 Sides, Intermediate Partitions and Backs

All sides, intermediate partitions and backs shall be constructed of minimum thick flattened expanded metal welded to angle iron frames with all exposed edges bond sheared.

##### 2.1.3 Frames

Frames shall be constructed of minimum angle iron steel continuously welded.

##### 2.1.4 Doors

Double doors shall be framed with minimum angle iron steel and infilled with minimum thick flattened expanded metal. A minimum thick steel panel with a minimum thick cold rolled steel back panel shall be welded to the center span of the door. Doors shall have a three-point three-sided cremone latch and shall be padlockable.

##### 2.1.5 Hinges

Door shall be hinged with minimum five-knuckle heavy duty steel pin butt hinges welded to both door and locker frame. Provide three hinges for single tier doors and two hinges for double tier doors.

##### 2.1.6 Number Plate

Provide one aluminum number plate on each locker door with number etched on face of plate. Lockers grouped in each individual room or space shall be numbered in sequential order.

#### 2.1.7 Hooks

Two single wall hooks shall be provided in each locker less than wide and three hooks shall be provided in spaces over wide. One double ceiling hook shall be provided in double tier lockers. Hooks shall be forged steel with ball ends and be zinc plated.

#### 2.1.8 Clothes Rod

Provide a galvanized or stainless steel clothes rod in place of ceiling hook in single tier lockers. Rod shall be mounted from side to side of locker space and be attached to side panels.

#### 2.1.9 Base

Closed welded steel base minimum thick shall be welded to locker bottom and be enclosed on all four sides. Base shall be approximately high.

#### 2.1.10 Finish

Exposed steel parts shall be given a coat of rust inhibitive phosphate treatment and then finished with a heavy coat of high quality baked enamel. Unless otherwise indicated, color shall be manufacturer's standard tan or gray.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

TA-50 storage lockers shall be installed in place in accordance with the approved manufacturer's installation instructions. Anchorage to concrete base shall be according to the manufacturer's recommendations.

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SECTION 10990

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## SECTION 10990

## MISCELLANEOUS BUILDING SPECIALTIES

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS

ASTM A 167	(1990) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 366	(1985) Steel, Carbon, Cold-Rolled Sheet, Commercial Quality
ASTM B 221	(1991) Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes

## 1.2 SUBMITTALS

Submit the following in accordance with Section entitled 01330, "Submittal Procedures."

## 1.2.1 SD-03, Product Data

Item A5145, Garment, Hook, Two Prong

Item A1145, Movable Shelving

Item A5210, TV Mounting Bracket

Item A6309, Roller Shades

Item A6309B, Roller Shades, Blackout

Item M0410D, Screen, Projection, 70 by 70 Inches

Walk-off Floor Mats

## 1.3 DELIVERY AND STORAGE

Items shall not be delivered to the site until the location of installation is ready for the item so that when they are delivered, they can be immediately installed, thus minimizing possibility of damage. Items when delivered shall be dry, free of warpage, and have packaging intact.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Stainless Steel

ASTM A 167, Class 304, for welded construction and Class 201, 202, 302 or 304 for construction formed without welding. Exposed surfaces of stainless steel shall have a satin finish.

#### 2.1.2 Aluminum Alloy

ASTM B 221 equivalent in ultimate tensile, yield, and shear strengths to Alloy 6063-T5 or 6063-T6.

#### 2.1.3 Sheet Steel

ASTM A 366, cold rolled sheets, commercial bright finish.

### 2.2 ITEMS

#### 2.2.1 Item A5145, Garment Hook, Two Prong

Two stainless steel or chrome plated steel hooks fabricated from flat strap stock 3/4 to 1 inch wide and configured to provide two hook points on each strap when oriented vertically. Two hooks shall be attached to a natural finished 3/4 inch thick Red Oak panel 6 inches wide by length required to space the hooks 8 inches apart with 2 inches clear on each end. Edges of wood panel shall be chamfered. Where two A5145's are shown side-by-side, provide four hooks on one oak panel 28 inches long.

#### 2.2.2 Item A5210, TV Mounting Bracket

Wall-mounted, yoke type bracket fabricated from steel and consisting of a single support arm, yoke support tube, yoke assembly, and platform. Yoke shall be suspended 16 inches from wall. Yoke assembly shall swivel 360 degrees and shall allow platform to tilt from 0 to 15 degrees. Yoke shall have a variable opening width of 15 3/4 to 22 1/4 inches and a variable opening height of 16 to 22 inches. Weight capacity shall be at least 200 pounds. Unit shall have a factory-applied black powder coat finish. Provide with a wall mount bracket for studs at 16 inches o.c. Manufacturers reference is Model WMY-1622 as manufactured by Da-Lite Screen Company, Inc.

#### 2.2.3 Item M0410D, Screen, Projection

Ceiling or wall-mounted units consisting of case, screen, mounting accessories and other components required for a complete installation.

##### 2.2.3.1 Viewing Screen

Screen material shall be mildew and flame resistant glass fiber fabric with top edge securely anchored in a rigid metal roller. Matte white viewing surface with minimum gain characteristics complying with Fed. Spec. GG-S-00172D(1) for Type A screen surface. Provide black masking borders. Size shall be 70 by 70 inches.

#### 2.2.3.2 Case

Screen case shall consist of a 22 gauge steel cover with a baked enamel finish and fitted with powder coated steel end caps with integral bearing surfaces to support roller ends. Roller shall be a spring-loaded cam-lock system with a slot to retain viewing screen without tape, glue, staples, or cords so that screen may be easily replaced yet cannot be pulled from roller.

#### 2.2.3.3 Mounting Accessories

End caps shall be provided with powder coated steel brackets that will allow wall or ceiling mounting.

#### 2.2.4 Item A1145, Movable Shelving

Movable shelving shall consist of nine (9) 120 by 24 inch mechanically assisted carriages, four (4) heavy-duty surface mounted tracks 27 feet by 3 1/2 inches wide, nine (9) 48 by 24 by 88 1/4 inch (W x D x H) starter units, and eighteen (18) 36 by 24 by 88 1/4 inch (W x D x H) adder units. All units shall be movable (no fixed or stationary units). All shelves shall be 18 gauge steel on 14 gauge shelf supports and shall be adjustable on 1 1/2 inch centers. Each unit shall have six (6) shelves without backs. Manufacturer's reference is Borroughs Easy-Trak Compacting or equal.

#### 2.2.5 Walk-off Floor Mats

Walk-off floor mats shall be flush with adjacent flooring; size and locations shall be as indicated on the drawings. Mats shall be extruded aluminum single tread design joined structurally by aluminum key lock bars. Each tread shall have manufacturer's standard poured epoxy abrasion strip continuous along the length of the tread. Treads shall be maximum 1 1/2 inches wide by 1/2 inch high. Maximum tread spacing shall be 1 1/2 inches on center. Each aluminum tread shall have two continuous cushion strips interlocked on the underside of the tread. Each mat shall be bordered by a recessed aluminum angle frame. Exposed aluminum on treads shall be anodized finish. Color of aluminum and abrasive strip shall be as indicated in Finish Schedule on drawings.

#### 2.2.6 Items A6309 and A6309B, Roller Shades

Roller shades consist of flexible fabric covering called a shade band, attached to and supported by a roller that is in turn supported by end brackets. This assembly shall be covered by an extruded aluminum snap-on fascia. The shade bank shall terminate in an aluminum bottom bar or rail. Roller shades shall be screw attached through the top cover to the window head. Each shade shall be manually operated by a continuous-loop bead chain, clutch, and tensioner. Finish of exposed metal shall be factory painted to match color of aluminum storefront framing. Manufacturer's reference shall be Mecho/5 as manufactured by MechoShade Systems, Inc.

##### 2.2.6.1 Item A6309, Sunscreen Shades

Roller shades with visually transparent single-fabric shade cloth. Manufacturer's reference is ThermoVeil Series 1300 as manufactured by MechoShade Systems, Inc.

## 2.2.6.2 Item A6309B, Blackout Shades

Roller shades with opaque single-fabric blackout material. Manufacturer's reference is ThermoVeil Series 0700 as manufactured by MechoShade Systems, Inc. Provide complete with blackout channels.

## PART 3 EXECUTION

## 3.1 INSPECTION

Installer must examine the areas and conditions under which miscellaneous items are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

## 3.2 INSTALLATION

Install all miscellaneous items where shown on the drawings and in strict accordance with the manufacturer's printed instructions. Touch up marred or damaged surfaces or replace if not acceptable to the Contracting Officer. Adjust items with movable parts for proper operation.

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SECTION 10999

FIRE EXTINGUISHER CABINETS

**10/97**

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SAVH-10999 (10/97)

## SECTION 10999

FIRE EXTINGUISHER CABINETS  
10/97

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire extinguisher cabinets

Shop drawings shall indicate thickness of materials, depth of cabinet and installation procedures.

## 1.2 GENERAL REQUIREMENTS

The contract drawings indicate the locations and details for the various sized extinguishers.

## PART 2 PRODUCTS

## 2.1 FIRE EXTINGUISHER CABINETS

Provide flat trim fully recessed; 2-1/2 inch rolled edge semirecessed or surface-mounted cabinets at locations shown on drawings. Cabinet shall have minimum interior box dimensions of 30 inches high, 12 inches wide and 8 inches deep. The fire extinguishers shall be furnished by the Government.

## 2.1.1 Materials

The fully recessed and semirecessed cabinets shall be constructed of minimum 18-gauge steel with a white baked enamel surface. Surface-mounted cabinets shall be constructed of aluminum with a clear satin anodized finish. All trim and doors are to be constructed of extruded aluminum and all corners are to be mitered. Trim and doors are to have a clear satin anodized finish. Doors are to be full glass and are to be glazed with tempered glass. Doors shall be fully hinged with piano type hinge and furnished with handle and latch.

## PART 3 EXECUTION

## 3.1 INSTALLATION

Cabinets shall be installed in accordance with approved instructions. Extinguisher cabinets shall be installed so that top is no more than 5 feet above the floor.

3.2 CLEANING

Windows of doors shall be cleaned on both exterior and interior.

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SECTION 11020

SECURITY VAULT DOOR

**08/02**

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-- End of Section Table of Contents --

## SECTION 11020

## SECURITY VAULT DOOR

08/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-D-600

(Rev C, Am 1) Door, Vault, Security

## 1.2 GENERAL REQUIREMENTS

The vault door unit shall be a steel security-vault type door with frame, and ramp type threshold, and shall be a standard product of a manufacturer specializing in this type of fabrication.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Vault door and frame

Show head, jamb, and sill sections, and elevations of the doors.

## SD-03 Product Data

Vault Door and Frame

Manufacturer's catalog data including catalog cuts and brochures. The data shall show that the proposed vault door unit conforms with the requirements in FS AA-D-600, and has been tested and approved by the General Services Administration (GSA).

## SD-07 Certificates

Vault Door and Frame

Certification shall state that vault-door units that do not bear the GSA label are constructed to Class 5 standards.

## SD-08 Manufacturer's Instructions

## Installation

Printed instructions and drawings provided by the manufacturer.

### 1.4 DELIVERY AND STORAGE

Door and frame assemblies shall be delivered to the jobsite in a protective covering with the brand and name clearly marked thereon. Materials delivered to the jobsite shall be inspected for damage, and unloaded with a minimum of handling. Storage shall be in a dry location with adequate ventilation, free from dust, water, and other contaminants, and which permits easy access for inspection and handling. Door assemblies shall be stored off the floor on nonabsorptive strips or wood platforms. Damage to doors and frames shall be prevented during handling. Damaged items that cannot be restored to like-new condition shall be replaced.

## PART 2 PRODUCTS

### 2.1 VAULT DOOR AND FRAME

Design and construction of the door and frame assembly shall conform to FS AA-D-600. The door shall be Class 5, Type I - with optical device, Style K - key change combination lock, Design S - single lock. Swing shall be as indicated on drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The vault door assembly shall be installed in strict compliance with the printed instructions and drawings provided by the manufacturer. After installation, the door, the locking mechanism, and the inner escape device shall be adjusted for proper operation.

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## DIVISION 13 - SPECIAL CONSTRUCTION

## SECTION 13080

## SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT

09/03

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## SECTION 13080

SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT  
09/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M	(2001) Carbon Structural Steel
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 153/A 153M	(2001a) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 500	(2001a) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 572/A 572M	(2001) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 603	(1998) Zinc-Coated Steel Structural Wire Rope
ASTM A 653/A 653M	(2002a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E 488	(1996) Strength of Anchors in Concrete and Masonry Elements

## ASME INTERNATIONAL (ASME)

ASME B18.2.1	(1996) Square and Hex Bolts and Screws, Inch Series
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts

## U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04	(1998) Seismic Design for Buildings
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## 1.2 SYSTEM DESCRIPTION

### 1.2.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the mechanical equipment and systems outlined in Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Seismic protection requirements shall be in accordance with TI 809-04 and additional data furnished by the Contracting Officer, and shall be provided in addition to any other requirements called for in other sections of these specifications. The design for seismic protection shall be based on a Seismic Use Group I building occupancy and on site response coefficients for  $S_{MS} = 0.60$  and  $S_{M1} = 0.33$ . Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. The basic force formulas, for Ground Motions A and B in Chapter 3 of TI 809-04, use the design spectral response acceleration parameters for the performance objective of the building, not for equipment in the building; therefore, corresponding adjustments to the formulas shall be required.

### 1.2.2 Miscellaneous Equipment and Systems

The bracing for the following miscellaneous equipment and systems shall be developed by the Contractor in accordance with the requirements of this specification:

Storage cabinets	Ornamentations
Storage Racks	Signs and Billboards
Shelving	Furnishings
Partitions	

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Bracing; G, AE  
Resilient Vibration Isolation Devices; G, AE  
Equipment Requirements; G, AE

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction. For equipment and systems in buildings that have a performance objective higher than life-safety, the drawings shall be stamped by the registered engineer who stamps the calculations required above.

#### SD-03 Product Data

Bracing; G, AE  
Equipment Requirements; G, AE

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

#### 1.4 EQUIPMENT REQUIREMENTS

##### 1.4.1 Rigidly Mounted Equipment

The following specific items of equipment: Boilers, chillers and air handling units to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in TI 809-04, Chapter 10. For any rigid equipment which is rigidly attached on both sides of a building expansion joint, flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions, shall be provided.

##### 1.4.2 Nonrigid or Flexibly-Mounted Equipment

The following specific items of equipment to be furnished: Pumps, fans, unit heaters shall be constructed and assembled to resist a horizontal lateral force of 1 times the operating weight of the equipment at the vertical center of gravity of the equipment.

### PART 2 PRODUCTS

#### 2.1 BOLTS AND NUTS

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153/A 153M.

#### 2.2 SWAY BRACING

Material used for members listed in this section and on the drawings, shall be structural steel conforming with the following:

- a. Plates, rods, and rolled shapes, ASTM A 36/A 36M ASTM A 572/A 572M, Grade 503. If the Contractor does the design, both ASTM A 36/A 36M and ASTM A 572/A 572M, grade 503 will be allowed.
- b. Wire rope, ASTM A 603.
- c. Tubes, ASTM A 500, Grade B.
- d. Pipes, ASTM A 53/A 53M, Type E or S, Grade B.
- e. Light gauge angles, less than 1/4 inch thickness, ASTM A 653/A 653M.

### PART 3 EXECUTION

#### 3.1 BRACING

Bracing shall conform to the arrangements shown. Trapeze-type hanger shall be secured with not less than two 1/2 inch bolts.

### 3.2 BUILDING DRIFT

Sway braces for a piping run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided.

### 3.3 ANCHOR BOLTS

#### 3.3.1 Cast-In-Place

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except as specified below. One nut shall be provided on each bolt. Anchor bolts shall conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

#### 3.3.2 Expansion or Chemically Bonded Anchors

Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. Expansion or chemically bonded anchors shall not be used to resist pull-out in overhead and wall installations if the adhesive is manufactured with temperature sensitive epoxies and the location is accessible to a building fire. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

##### 3.3.2.1 General Testing

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than 24 hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

##### 3.3.2.2 Torque Wrench Testing

Torque wrench testing shall be done on not less than 50 percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for 3/8 inch sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

##### 3.3.2.3 Pullout Testing

Expansion and chemically bonded anchors shall be tested by applying a



pullout load using a hydraulic ram attached to the anchor bolt. At least 5 percent of the anchors, but not less than 3 per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to 1 times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

### 3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS, except that an equipment weight equal to five times the actual equipment weight shall be used.

#### 3.4.1 Resilient and Spring-Type Vibration Devices

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 0.5 inches.

### 3.5 SWAY BRACES FOR PIPING

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those shown on the drawings. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400A PLUMBING, GENERAL PURPOSE. Bracing shall consist of at least one vertical angle 2 x 2 inches x 16 gauge and one diagonal angle of the same size.

#### 3.5.1 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided in accordance with Section 15070ASEISMIC CONTROL FOR MECHANICAL EQUIPMENT.

#### 3.5.2 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

#### 3.5.3 Maximum Length for Anchor Braces

Type	Size (Inches)	Maximum Length* (Feet/Inches)
Angles	1-1/2 x 1-1/2 x 1/4	4-10

Type	Size (Inches)	Maximum Length* (Feet/Inches)
	2 x 2 x 1/4	6-6
	2-1/2 x 1-1/2 x 1/4	8-0
	3 x 2-1/2 x 1/4	8-10
	3 x 3 x 1/4	9-10
Rods	3/4	3-1
	7/8	3-8
Flat Bars	1-1/2 x 1/4	1-2
	2 x 1/4	1-2
	2 x 3/8	1-9
Pipes (40S)	1	7-0
	1-1/4	9-0
	1-1/2	10-4
	2	13-1

#### 3.5.4 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

### 3.6 EQUIPMENT SWAY BRACING

#### 3.6.1 Suspended Equipment and Light Fixtures

Equipment sway bracing shall be provided for items supported from overhead floor or roof structural systems, including light fixtures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 1/2 inch bolts. Sufficient braces shall be provided for equipment to resist a horizontal force as specified in Chapter 10 of TI 809-04 without exceeding safe working stress of bracing components. The Contractor shall provide, for approval, specific force calculations in accordance with Chapter 10 of TI 809-04 for the equipment in the project. Details of equipment bracing shall be submitted for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

#### 3.6.2 Floor or Pad Mounted Equipment

##### 3.6.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

##### 3.6.2.2 Overturning Resistance

The ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. Calculations

shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

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## SECTION 13100A

LIGHTNING PROTECTION SYSTEM  
07/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.30 (1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 780 (2000) Installation of Lightning Protection Systems

## UNDERWRITERS LABORATORIES (UL)

UL 96 (1994; Rev thru Jan 2000) Lightning Protection Components

UL 96A (2001) Installation Requirements for Lightning Protection Systems

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL Elec Const Dir (2004) Electrical Construction Equipment Directory

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

## 1.2.2 System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved design. The lightning protection system shall conform to NFPA 70 and NFPA 780, UL 96 and UL 96A, except where requirements in excess thereof are specified herein.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Drawings; G, RE

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

#### SD-07 Certificates

Materials; G, RE

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in UL Elec Const Dir will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted. A letter of findings shall be submitted certifying UL inspection of lightning protection systems provided on the following facilities: COF and HQ buildings.

### 1.4 Drawings

Provide detailed drawings of complete lightning protection system layouts and of material used.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

### 2.1.2 Main and Secondary Conductors

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.

#### 2.1.2.1 Copper

All conductors shall be copper. Counterpoise shall be copper conductors not smaller than No. 1/0 AWG.

#### 2.1.3 Air Terminals

Terminals shall be in accordance with UL 96 and NFPA 780. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides not less than one-half the height of the terminal.

#### 2.1.4 Ground Rods

Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to ANSI C135.30. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length.

#### 2.1.5 Connectors

Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation.

#### 2.1.6 Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, clips, and fasteners shall conform to UL 96, classes as applicable.

## PART 3 EXECUTION

### 3.1 INTEGRAL SYSTEM

#### 3.1.1 General Requirements

The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Secondary conductors shall interconnect with grounded metallic parts within the building. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

##### 3.1.1.1 Air Terminals

Air terminal design and support shall be in accordance with NFPA 780. Terminals shall be rigidly connected to, and made electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal and connected to the air terminal by a dowel or threaded fitting. Air terminals at the ends of the structure shall be set not more than 2 feet from the ends of the ridge or edges and corners of roofs. Spacing of air terminals 2 feet in height on ridges, parapets, and around the perimeter of buildings with flat roofs shall not exceed 25 feet.

In specific instances where it is necessary to exceed this spacing, the specified height of air terminals shall be increased not less than 2 inches for each foot of increase over 25 feet. On large, flat or gently sloping roofs, as defined in NFPA 780, air terminals shall be placed at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings, and other metal objects that do not contain hazardous materials and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals. However, these metal objects shall be bonded to the lightning conductor through a metal conductor of the same unit weight per length as the main conductor.

#### 3.1.1.2 Roof Conductors

Roof conductors shall be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns shall have a radius of not less than 8 inches. Conductors shall preserve a downward or horizontal course and shall be rigidly fastened every 3 feet along the roof and down the building to ground. All connections shall be electrically continuous. Roof conductors shall be coursed along the contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs shall be connected to form a closed loop.

#### 3.1.1.3 Down Conductors

Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes. Down conductors shall be coursed over extreme outer portions of the building, such as corners, with consideration given to the location of ground connections and air terminals. Each building or structure shall have not less than two down conductors located as widely separated as practicable, at diagonally opposite corners. On rectangular structures having gable, hip, or gambrel roofs more than 110 feet long, there shall be at least one additional down conductor for each additional 50 feet of length or fraction thereof. On rectangular structures having French, flat, or sawtooth roofs exceeding 250 feet in perimeter, there shall be at least one additional down conductor for each 100 feet of perimeter or fraction thereof. On structures exceeding 50 feet in height, there shall be at least one additional down conductor for each additional 60 feet of height or fraction thereof, except that this application shall not cause down conductors to be placed about the perimeter of the structure at intervals of less than 50 feet. Additional down conductors shall be installed when necessary to avoid "dead ends" or branch conductors ending at air terminals, except where the air terminal is on a roof below the main protected level and the "dead end" or branch conductor is less than 16 feet in length and maintains a horizontal or downward coursing. Down conductors shall be equally and symmetrically spaced about the perimeter of the structure.

#### 3.1.1.4 Interconnection of Metallic Parts

Metal doors, windows, and gutters shall be connected directly to the grounds or down conductors using not smaller than No. 6 copper conductor, or equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical



capacity than would normally be used, or shall be protected. The ground connection to metal doors and windows shall be by means of mechanical ties under pressure, or equivalent.

#### 3.1.1.5 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

#### 3.1.1.6 Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 3 feet, nor more than 8 feet, from the structures foundation. The complete installation shall have a total resistance to ground of not more than 5 ohms using a counterpoise. Ground rods shall be tested individually prior to connection to the system and the system as a whole shall be tested not less than 48 hours after rainfall. When the resistance of the complete installation exceeds the specified value or two ground rods individually exceed 10 ohms, the Contracting Officer shall be notified immediately. The counterpoise shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structures in a trench not less than 2 feet deep at a distance not less than 3 feet nor more than 8 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous.

#### 3.1.2 Metal Roofs

Wood-Frame, Wall-Bearing Masonry or Tile Structure with Metallic Roof and Nonmetallic Exterior Walls, or Reinforced Concrete Building with Metallic Roof: Metal roofs which are in the form of sections insulated from each other shall be made electrically continuous by bonding. Air terminals shall be connected to, and made electrically continuous with, the metal roof as well as the roof conductors and down conductors. Ridge cables and roof conductors shall be bonded to the roof at the upper and lower edges of the roof and at intervals not to exceed 100 feet. The down conductors shall be bonded to roof conductors and to the lower edge of the metal roof.

Where the metal of the roof is in small sections, the air terminals and down conductors shall have connections made to at least four of the sections. All connections shall have electrical continuity and have a surface contact of at least 3 square inches.

#### 3.1.3 Steel Frame Building

The steel framework shall be made electrically continuous. Electrical continuity may be provided by bolting, riveting, or welding steel frame, unless a specific method is noted on the drawings. The air terminals shall be connected to the structural steel framework at the ridge. Short runs of

conductors shall be used as necessary to join air terminals to the metal framework so that proper placing of air terminals is maintained. Separate down conductors from air terminals to ground connections are not required. Where a grounded metal pipe water system enters the building, the structural steel framework and the water system shall be connected at the point of entrance by a ground connector. Connections to pipes shall be by means of ground clamps with lugs. Connections to structural framework shall be by means of nut and bolt or welding. All connections between columns and ground connections shall be made at the bottom of the steel columns. Ground connections to grounding electrodes or counterpoise shall be run from not less than one-half of all the columns distributed equally around the perimeter of the structure at intervals averaging not more than 60 feet.

### 3.2 INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

-- End of Section --

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## SECTION 13125

## ANTENNA TOWER

## PART 1 GENERAL

## 1.1 REFERENCES

This specification establishes minimum standards for the design, fabrication and installation of latticed steel guyed and self-supporting towers including Portland Cement concrete foundations.

## ASTM INTERNATIONAL (ASTM)

ASTM A 153	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(2002) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 449	(2000) Quenched and Tempered Steel Bolts and Studs
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

## ELECTRONIC INDUSTRIES ALLIANCE / TELECOMMUNICATIONS INDUSTRIES ASSOCIATION (EIA/TIA)

EIA/TIA-222-F	Steel Antenna Towers and Antenna Supporting Structures
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## FEDERAL AVIATION ADMINISTRATION ADVISORY CIRCULAR

AC 70/7460-1K	Obstruction Marking and Lighting
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 780	(2003) Installation of Lightning Protection Systems

## OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1910	OSHA Standards, Part 1910
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## 1.2 SCOPE

This specification establishes minimum standards for the design, fabrication and installation of latticed steel guyed and self-supporting

towers including Portland Cement concrete foundations.

### 1.3 QUALITY CONTROL

The Contractor shall employ a quality control program that will ensure that engineering, fabrication, erection and related activities meet the requirements of this specification. Contractor's Quality Assurance Program shall also meet requirements for AISC Certification. A copy of the Contractor's Quality Assurance Program must be available for review by the Government.

### 1.4 CONTRACTOR'S WARRANTY

The Contractor shall guarantee all materials and workmanship under his contract against defects or incorrect installation for a period of one year after completion. Repair or replacement of any defective materials, correction of faulty workmanship, or correction of any items not in accordance with these specifications shall be made at the contractor's expense.

### 1.5 EXTENDED GUARANTEE

The Contractor shall further guarantee all material supplied under these specifications for a period of not less than twenty years against failure from structural defects.

### 1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Design Calculations; G, RE  
Design Drawings; G, RE

## PART 2 PRODUCTS

### 2.1 DESIGN PARAMETERS

Tower and supporting concrete foundation shall be designed in accordance with the requirements as set forth in these specifications.

#### 2.1.1 Design Wind Load

The design basic wind speed shall be as defined for the site by EIA/TIA-222-F but in no case shall it be less than 120 miles per hour.

#### 2.1.2 Sway and Twist

The maximum sway at maximum wind load of this type structure shall be 2 degrees from vertical. The maximum twist at maximum wind load shall be 2 degrees.

### 2.1.3 Design Ice Load

The design shall include a minimum thickness of solid radial ice, as defined in EIA/TIA-222-F, of 0.5 inch. Ice shall be included on the tower structure, antennas, appurtenances, waveguides and transmission lines.

### 2.1.4 Antennas/Coax Cables

Below is the antenna and coax information for calculation of loading on the Tower.

Antenna	Manufacturer/Model	Coax
#1	Andrew DB 224 Dipole	1/2 inch
#2	Andrew DB 224 Dipole	1/2 inch
#3	Andrew DB 224 Dipole	1/2 inch
#4	Andrew 63305A Bifilar Helical	7/8 inch
#5	Andrew 63305A Bifilar Helical	7/8 inch
#6	Andrew 63305A Bifilar Helical	7/8 inch

### 2.1.5 Wind Directions

The effects due to the wind blowing in two directions, toward and perpendicular to one tower face (face loading) and toward one tower leg (apex loading) must be considered in determining the maximum design loads.

### 2.1.6 Antenna Forces

The forces due to all antennas shall be considered in the design analysis. Antenna wind forces shall be developed for wind direction(s) relative to the tower and antenna distribution as a whole which will produce the maximum forces in the individual elements of the support structures for use in design. This requires the computation of antenna wind forces at various angles (azimuths) relative to the pointing direction of each antenna.

#### 2.1.6.1 UHF or VHF Antennas

Antenna wind and gravity forces shall be based upon the load requirements for discrete appurtenances as defined in EIA/TIA-222-F.

### 2.1.7 Effective Length of Compression Members

- An effective length factor (K) of 1.0 shall be used to calculate the effective length and allowable stress for tower leg members and bracing members whose ends are attached by a single bolt.
- Ends of compression members shall be supported in two directions orthogonal to the member at each end.
- Intersection points of diagonals in X-braced sections shall not be considered as points of full lateral support for design unless an additional member is provided at the intersection to resist buckling out-of-plane.

### 2.1.8 Allowable Stress

All tower components and supporting elements shall be selected such that the unit stresses resulting from the specified loads shall not exceed allowable unit stresses of the "Specification for Structural Steel

Buildings Allowable Stress Design and Plastic Design" issued by American Institute of Steel construction.

#### 2.1.9 Sub-Standard Soils

Anchor and foundation designs shall be based upon the soil characteristics and parameters listed in the site geotechnical report supplied by the Government. Foundation designs shall not be based upon EIA defined parameters for "normal soil" when sub-standard soils exist at the site.

#### 2.1.10 Bolted Construction

Tower sections shall be of bolted construction to permit in-service replacement of members. Shop welding shall be kept to a minimum and field welding is not permitted.

#### 2.1.11 Self-Supporting Tower Design

##### 2.1.11.1 Anchorage

Self-supporting towers shall be designed to mount to concrete foundations by the use of cast-in-place anchor bolts. The practice of embedding mating tower members, special fixtures and other such unique methods shall not be permitted.

##### 2.1.11.2 Design Considerations

A self-supporting tower shall be designed as a space truss, taking into effect the following with the previously listed wind and ice loads.

- a. Dead load of all tower and supported elements with ice.
- b. Torsion and shear effects produced by wind load on eccentrically mounted antennas and other equipment.
- c. The effects of eccentric loads at the connections of the tower members.
- d. Stresses due to lateral loads on members attached between panel points.

##### 2.1.11.3 Straight Section Limitations

For tapered face towers that incorporate a straight segment at the top, the length of straight segment shall be limited to 5 times the face width of the straight segment when microwave antennas are located within the straight section.

The height of the straight segment shall be limited to twelve times the face width of the straight segment.

##### 2.1.11.4 Internal Bracing

All K-braced or reversed K-braced sections shall be designed to include a structurally stable configuration of internal bracing at the midpoint of horizontal members.



#### 2.1.12 Eccentricity Minimized

Connections shall be detailed and designed to minimize stresses attributable to eccentricity.

#### 2.1.13 Easy Inspection

All members and connections shall be selected and detailed to allow easy inspection of all surfaces and for ease in applying corrosion prevention materials. Proper drainage of all moisture and condensation shall be provided for all members.

### 2.2 MATERIALS

#### 2.2.1 Tower Legs

Tower legs shall be fabricated from structural steel shapes or formed from plate having a minimum yield strength of 50,000 psi. The use of open shape legs facilitates subsequent strengthening and expandability of the tower, and promotes proper coverage and inspection of hot dipped galvanized surfaces, minimizing the possibility of premature corrosion.

#### 2.2.2 Tower Bracing

The tower bracing shall be fabricated of structural steel or formed plate open shapes having a minimum yield strength of 36,000 psi. Diagonal "X-bracing" shall be provided in every tower section supporting a torque stabilizer.

#### 2.2.3 Fasteners

All fasteners shall have been manufactured in North America. Certificates of origin shall be provided to the Government.

##### 2.2.3.1 Bolts

- a. Bolts used in any calculated load carrying connection shall be a high strength bolt as defined below and a minimum of 1/2 inch in diameter. Under no circumstances shall a bolt less than 3/8 inch in diameter be utilized.
- b. High strength bolts conforming to ASTM A 325 or ASTM A 449 shall be used in all calculated load carrying connections. Bolts other than high strength, shall conform to ASTM A 307.
- c. All threaded fasteners shall be of adequate length that a minimum of two threads shall protrude beyond the nut or locking device when the nut is properly tensioned.
- d. All hardware must be hot dipped galvanized in accordance with the provisions of ASTM A 153.

#### 2.2.4 Minimum Thickness

The minimum thickness of any fabricated steel part shall be 1/8 inch.

#### 2.2.5 Filler Plates

Spaces 1/8 inch or greater between parallel or crossing members shall be

filled with single thickness plates or ring fills. Stacked washers shall not be used for this purpose.

#### 2.2.6 Oversized and Slotted Holes

Hardened flat washers shall be provided for all oversized or slotted holes.

#### 2.2.7 Anchor Bolts

Anchor bolts shall be designed such that their projection above the concrete allows for one leveling nut below and two full-sized nuts above the base plate of the tower.

#### 2.2.8 Dissimilar Metals

Contact between dissimilar metals shall not be permitted.

### 2.3 FOUNDATION

The Contractor's foundation design shall be based on the government provided Geotechnical report. See Division 3 of these specifications for requirements for cast-in-place concrete. See Section 2.4 below for submittal requirements.

### 2.4 DESIGN CALCULATIONS AND DRAWINGS

Complete sets of the tower design drawings and design calculations shall be furnished to the Government. All submittals must bear a Professional Engineer's stamp. The engineer must be licensed in the state where the tower site is located.

#### 2.4.1 Design Calculations

The Contractor shall submit structural calculations, foundation, and erection drawings for each tower site location sealed by the Contractor's Professional Engineer. Complete structural calculations are required covering all parts of the structures and all related items including the foundation. Actual stresses and corresponding allowable stresses shall be listed for the vertical, diagonal and, girt members of the tower. Tower twist, sway, and displacement calculations shall be made and identified for each microwave antenna. When computer printouts form a portion of the calculations, the Contractor shall include sufficient information to allow an independent engineer to thoroughly review the design.

#### 2.4.2 Drawings

- a. Drawings must include the station name, tower height, manufacturer's name, manufacturer's model number, antenna path azimuths, and elevation and plan views of the tower indicating the tower orientation.
- b. In addition, the Contractor shall furnish section assembly drawings showing all tower members with their part numbers, splice plates, ladder mounting details, bolt sizes and types, and any other information necessary to identify each tower component. Antenna mounting assembly drawings including all components necessary for supporting the antennas and their side arm struts plus miscellaneous drawings showing the supporting elements shall be provided.

## 2.5 TOWER ACCESSORIES

### 2.5.1 Platform and Antenna Supports

Provide 10 feet triangular antenna platform with 8 feet antenna mounting masks.

### 2.5.2 Climbing Ladder

Provide an internal climbing ladder from the base to the tower top. The rung width shall be at least 12 inches with the diameter being a minimum of 5/8 inch. The maximum step spacing shall be 16 inches. The step spacing shall be uniform throughout the ladder length. Provide a 20 foot anti-climb section at tower base to prevent unauthorized persons from climbing tower.

### 2.5.3 Safety-Climb Device

Tower shall be provided with a flexible (cable) ladder safety device. In addition to the necessary brackets, guides, and clamps, the following shall be provided: 3/8 inch diameter strand for the carrier to run the full height of the tower and a D-ring nylon safety belt with connectors and a detachable safety sleeve mechanism.

### 2.5.4 Vertical Waveguide/Coax Support

Support members shall be provided for all proposed waveguide/coax runs. The maximum vertical spacing shall be as prescribed by the waveguide/coax manufacturer, and shall not exceed 4 feet. The supporting members shall accommodate the attachment of either metal hangers ("butterfly straps") or Andrew "Snap-in" hangers without the need for angle adaptors. The location of all waveguide/coax runs shall clearly be shown on the installation drawings. Attachment of waveguide/coax directly to tower legs is not acceptable.

### 2.5.5 Horizontal Waveguide/Coax Bridge

A horizontal waveguide/coax bridge shall be provided between the tower and the building. It shall be supported from 3 1/2 inch O.D. posts with concrete foundations. Connections to the building wall or tower shall not be permitted. The distance between tower face and building shall be as shown on the site plan. The bridge shall be capable of supporting and covering all the specified waveguide/coax runs between the tower and the entry ports within the building and shall provide protection against falling ice.

## 2.6 TOWER PAINTING

### 2.6.1 Scope

This specification sets forth the requirements for painting steel towers requiring obstruction marking. All painting shall comply with "Obstruction Marking and Lighting," AC 70/7460-1K, published by the U.S. Department of Transportation Federal Aviation Administration and be in accordance with the manufacturer's instructions. If no obstruction marking is required, tower shall be painted dark bronze.

## 2.6.2 Painting

All painting shall comply with specification Section 09900 "PAINTS AND COATINGS."

## 2.7 TOWER LIGHTING

### 2.7.1 Drawing Requirements

Submit schematic and installation drawings of the obstruction lighting system which shall be in accordance with FAA Advisory Circular AC 70/7460-1K, and NFPA 70 and NFPA 780. All equipment, conductors and their installation shall meet or exceed the requirements of the latest National Electric Code (NEC).

### 2.7.2 System Description

Items such as conduit, conductors, etc., shall be provided and installed for a complete working installation; this shall include final connections inside building housing the electronic equipment. The obstruction light controller shall be installed on the interior wall of the building with a remote photo cell mounted on the north side of the building roof line.

### 2.7.3 Standard Red Obstruction Lighting

Red lighting systems shall be composed of a L-864 (red) omni-directional and L-810 side lights. The number, configuration, and operation shall comply with "Red Obstruction Lighting Standards," Chapter 5 of FAA Advisory Circular AC 70/7460-1K. The controller, as described in this specification, shall be used with the red lighting system.

### 2.7.4 Lighting Controller (Red Obstruction)

The obstruction light control and alarm system, shall employ solid state circuitry, shall be self-contained (except for AC power) and shall provide reliable control of obstruction lights with "fail safe" type alarming of all functions. In addition, the control system shall incorporate the following:

- 1) Automatic On-Off: Adjustable automatic turn-on and turn-off of obstruction lights shall occur at a predetermined light level of 35 foot-candles turn-on and 60 foot-candles turn-off as required by FAA and FCC rules.
- 2) Photo Electric Cell Indicator: Indication of when lights turn-on and off shall be provided.
- 3) Light Failure Alarm: Alarm indication of one or more lights burned-out shall be provided.
- 4) Power Failure Alarm: Alarming of AC power failure to the unit shall be provided by combining alarms. All alarms shall come on to show primary power failure.
- 5) Automatic Circuit Restoration: Immediate automatic restoration of all alarms and control circuits upon restoration of AC power without cycling shall be provided.
- 6) AC Power Line Isolation: Control and alarm circuits shall be

isolated from the AC power line for added protection from voltage spikes.

7) Load Ballast Resistor Option: Controls shall be provided for the optional use of a load ballast resistor.

8) Solid State Relays: Solid state relays shall be provided for light control to achieve zero voltage switching "soft turn-on"; this prevents RFI and increases lamp life.

9) Off-time Delay Circuit: An off-time delay circuit shall be provided to bypass false input signals due to lightning flashes and other random interferences.

10) NO and NC Alarm Contacts: Controller to have normally open and normally closed independent alarm contacts for all alarm functions.

11) Led Status Indicators and Test Switches: Controller to have led status indicators and test switches to allow checking controller functions at controller.

12) Circuit Breakers: Controller to have resettable circuit breakers on outbound lines to protect system.

13) Controller Housing: Controller Housing to be NEMA 4-4X indoor/outdoor so it can be mounted in an enclosure or outside.

14) Isolated Alarms: Controller to have toroidal current sensing to isolate output lines from the sensing circuitry.

#### 2.7.5 Wiring Methods and Testing

##### 2.7.5.1 Type

Wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit, per section 16415A, ELECTRICAL WORK, INTERIOR.

##### 2.7.5.2 Conduit Size

Conduit shall be 3/4 inch unless a larger size is required by code.

##### 2.7.5.3 System Testing

Lighting equipment shall be operated to demonstrate suitability and compliance with approved shop drawings. An operational manual and warranty shall be provided for lighting equipment. The Contractor shall also provide bulbs in sufficient quantity for the initial installation plus one complete change-out.

##### 2.7.5.4 Local Government Inspection

Where local government bodies require inspection prior to the local Power Company hookup, the Contractor shall comply and be responsible for coordination of the inspection.

## 2.7.6 Beacon and Obstruction Lamp Bulbs

### 2.7.6.1 Bulbs - Two Sets

A complete set of spare or replacement bulbs shall be supplied in addition to all bulbs required for the initial installation.

## 2.8 TOWER GROUNDING

Ground Tower to building lightning protection system as shown on electrical drawings.

## 2.9 LIGHTNING PROTECTION

Provide air terminals (minimum of one) on extension post on top of tower platform. Connect air thermals to lightning protection system per section 13100A, LIGHTNING PROTECTION SYSTEM.

## 2.10 TOWER MANUFACTURING

### 2.10.1 AISC Certification

The manufacturer's plant shall be certified by the American Institute of Steel Construction, Inc. to have the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to produce fabricated structural steel of the required quality for Category I, Conventional Steel Structures as set forth in the AISC Certification Program.

### 2.10.2 Material Certification

All materials shall be new. Mill certificates shall be available for all materials furnished and shall be submitted to the Government upon request. Where mill certificates are not available, and/or the Government reasonably suspects that substandard materials were used in the fabrication, the manufacturer shall prepare coupons and other samples for testing, shall have these tested by a certified laboratory, and shall cause the results to be submitted directly to the Government from said laboratory. The manufacturer shall pay all costs associated with such testing. Should the suspect material prove to have qualities below those of ASTM or other governing specifications, the manufacturer shall replace all substandard materials at his own expense.

### 2.10.3 Part Numbers

Each fabricated structural member shall be stamped with a part number which shall be clearly legible after galvanizing and painting. The part numbers are to be a minimum of 1/2 inch in height and shall be as specified on the installation drawings.

### 2.10.4 Welding

- a. Certification of Welders: Welding shall be performed to the requirements of AWS-D1.1. Welders employed in the fabrication of towers for the Government shall be certified according to the type of welds being made, under the requirements of the AWS. Current qualification certificates for welders shall be made available to the Government upon request. Accurate records of assigned welders on the Government's towers shall be kept.

#### 2.10.5 Galvanizing

All ferrous metal shall be hot dip zinc galvanized according to the applicable ASTM Standards after fabrication. All surfaces (especially climbing ladders) shall be free of burrs and zinc "runs" which may form during the galvanizing process.

#### 2.10.6 Packaging

Packaging shall comply with British Standards Institute BS1133 Packing code. Each pallet, bundle, barrel, reel, and container shall clearly be labeled with a number and site name corresponding to a tower packing list for the specific site. The container in which a weather proofed packing list has been inserted shall be so identified and marked that the receiver can readily locate it.

##### 2.10.6.1 Structural Member Bundles and Pallets

Structural members shall be banded together in bundles or on pallets with similar items to be field assembled in a unit such as for one tower section. No bundle or skid weight can exceed 15,000 pounds. Adequate protection and support shall be provided to prevent shipping damage.

##### 2.10.6.2 Hardware Containers

Hardware items and all threaded fasteners shall be packaged according to size in rugged weather resistant containers.

#### 2.10.7 Packaging Documentation

##### 2.10.7.1 Detailed Material List

A detailed packing list shall accompany each shipment. Every item within the shipment shall be identified with part number and/or size description along with the unit weights. The list shall be weatherproofed to prevent moisture damage.

##### 2.10.7.2 Container and Weight Summary

A summary sheet shall be included listing the total number of barrels, bundles, boxes, reels, pails and other container units. The total shipment weight and the weight of each container unit shall be shown.

#### 2.11 WALL FEED THROUGH

Wall feed through shall have six 4-inch openings, feed through shall be approximately 15 inches wide by 18 inches high and painted with primer, ready for field painting.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Contractor Responsibilities

##### 3.1.1.1 Contractor Furnished Items

Contractor shall furnish all transportation, handling, storage materials,

labor, tools, implements, machinery, supplies, and incidentals, and shall do all things necessary to perform and complete the Work at the tower site.

#### 3.1.1.2 On-Site Supervision

The Contractor shall furnish to the Government the name, local address, and telephone number of the on-site supervisor. Furthermore, he shall promptly notify the Government of any changes in supervision or any changes in the supervisor's local address or telephone number.

#### 3.1.1.3 Protection of Existing Assets

The Contractor shall protect all existing buildings, structures and equipment during the assembly, erection, and painting of the tower. Protective coverings shall be provided against falling objects, including paint. The Contractor shall be liable for any damage caused to such buildings and equipment.

#### 3.1.1.4 Verification of Previous Work

Prior to any erection work, the Contractor shall check all foundations to ensure that size, location, alignment, and bolt spacing is in accordance with the site drawings.

#### 3.1.1.5 Erection Dependent Upon Foundation Cure

No steel shall be erected on tower foundations for a period of at least 7 days after the last concrete has been poured and the results of the 7-day breaks are satisfactory.

#### 3.1.1.6 OSHA Safety

The Contractor shall conduct the erection operation at all times within compliance of the OSHA Safety Act, 29 CFR 1910.

#### 3.1.1.7 Equipment Maintenance

All erection equipment and tools shall be maintained in first class working condition and in sufficient sizes and quantities to efficiently and safely perform their intended functions and the requirements of this contract.

#### 3.1.1.8 Equipment Calibration

All measuring devices such as transits shall be in proper calibration. Written confirmation from a certified laboratory that such instruments have been calibrated within the prior 6-month period before erection is to commence may be required by the Government. At least one transit shall be present and utilized throughout the erection process.

#### 3.1.1.9 Antenna Azimuth Stakes

The Contractor shall provide ground stakes on line with each antenna azimuth. Two stakes shall be provided for each path. The first stake will be placed at a distance from the tower approximately equal to the tower height. The second will be placed approximately 100 feet beyond the first. Each stake shall be clearly marked showing the azimuth of that path.



#### 3.1.1.10 Connection Inspection

The contractor shall inspect a representative random sample of not less than 10 percent of the bolted connections. If more than 5 percent of those connections tested are defective, the sampling frequency shall be increased to 20 percent. Only non-destructive testing methods shall be employed. Test results shall be submitted to the Government.

#### 3.1.1.11 Clean Work Area

Contractor shall ensure daily and at the completion of the installation that the working area is in order and clean. Contractor shall remove and properly dispose of all packing materials, shipping crates, concrete form work materials, and excess installation materials and hardware.

#### 3.1.1.12 Site Maintenance and Restoration

The Contractor shall maintain the site in the same condition as existed prior to the commencement of his operations. Any damage, such as but not limited to fences, driving surfaces, crops or ground cover, which may occur as a result of his operations shall be repaired or replaced by the Contractor at his own expense.

#### 3.1.2 Temporary Obstruction Marking and Lighting

For towers requiring lights, the tower steel shall be marked and/or lighted in accordance with the requirements of FAA Advisory Circular AC 70/7460-1K.

##### 3.1.2.1 Nighttime Lighting

Temporary obstruction lighting during construction shall be provided in accordance with the requirements of FAA Advisory Circular AC 70/7460-1K. Lighting shall be operative from sunset and at times of low visibility as required by the FAA Circular. The Government shall make all arrangements for and furnish the required electrical power to the site.

#### 3.1.3 Assembly

##### 3.1.3.1 Bolt Installation

- a. All bolts used for connecting vertical members shall be installed with their heads on the inside of the tower and the nuts on the outside. For vertically installed bolts, the nuts shall be installed on the upper side of the connected members.
- b. Bolts will be tensioned according to tower manufacturer's recommendation. In the absence of other instructions, the "turn-of-nut" method as specified in AISC's Manual of Steel Construction shall be utilized with A325 bolts and a "snug-tight" condition, as defined in the AISC Manual, shall be attained for A307 and A449 bolts.

##### 3.1.3.2 Drift Pin Use Limited

Drift pins will be permitted only to bring several parts together. They shall not be used in a manner which will distort or damage the metal or to enlarge unfair holes.

#### 3.1.3.3 Field Drilling Limited

Field drilling or reaming of holes in new tower material shall not be permitted except with the Government's approval. Any ungalvanized ferrous metal surfaces shall be treated with two coats of a zinc rich paint in accordance with the provision of ASTM A 780 Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings. The dried film coating of the paint used must contain a minimum of 94 percent zinc dust by weight as required by the ASTM Specification.

#### 3.1.3.4 Field Welding Prohibited

Field welding or burning shall not be permitted.

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## SECTION 13720A

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## SECTION 13720A

## CARD ACCESS SYSTEM - MAIN SYSTEM

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## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI INCITS 92 (1981; R 1998) Data Encryption Algorithm

ANSI INCITS 154 (1988; R 1999) Office Machines and Supplies - Alphanumeric Machines-Keyboards Arrangement

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/EIA/TIA-232-F (2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

EIA ANSI/TIA/EIA-568-A (1995; Addendum 3 1998) Commercial Building Telecommunications Cabling Standard - 3 Parts

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE Std 142 (1992) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1 (2001) Industrial Control and Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code



## UNDERWRITERS LABORATORIES (UL)

UL 294	(1999; Rev thru Oct 2001) Access Control System Units
UL 639	(1997; Rev thru Mar 1999) Intrusion Detection Units
UL 681	(1999; Rev thru Jan 2001) Installation and Classification of Burglar and Holdup Alarm Systems
UL 796	(1999; Rev thru Dec 2001) Printed-Wiring Boards
UL 1037	(1999) Antitheft Alarms and Devices
UL 1076	(1995; Rev thru Feb 1999) Proprietary Burglar Alarm Units and Systems

## 1.2 SYSTEM DESCRIPTION

The Contractor shall provide a Card Access System as described. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15. Electronic equipment shall comply with 47 CFR 15.

## 1.2.1 Central Station

The central station shall be configured to provide operator interface, interaction, dynamic and real time monitoring, display, and control. The central station shall control system networks to interconnect all system components including subordinate or separate control stations, enrollment stations and field equipment. The system shall be able to manage up to 16,000 uniquely identifiable inputs and outputs.

## 1.2.2 Field Device Network

The field device network shall provide communication between a central control station and field devices of the system. The field device network shall be configured as shown in the drawings. Field devices shall consist of alarm annunciation local processors and entry control local processors. Each field device shall be interrogated during each interrogation cycle. The field device network shall provide line supervision that detects and annunciates communications interruptions or compromised communications between any field device and the central station.

## 1.2.3 Field Equipment

Field equipment shall include local processors, sensors and controls. Local processors shall serve as an interface between the central station and sensors and controls. Data exchange between the central station and the local processors shall include down-line transmission of commands, software and databases to local processors. The up line data exchange from the local processor to the central station shall include status data such as intrusion alarms, status reports and entry control records. Local processors are categorized as alarm annunciation or entry control.

#### 1.2.4 Overall System Reliability Requirements

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours.

#### 1.2.5 Error Detection and Retransmission

A cyclic code error detection method shall be used between local processors and the central station.

#### 1.2.6 System Definitions

##### 1.2.6.1 Intrusion Alarm

An alarm resulting from the detection of a specified target, caused by an attempt to intrude into the protected area, or when entry into an entry controlled area is attempted without successfully using entry control procedures.

##### 1.2.6.2 Nuisance Alarm

An alarm resulting from the detection of an appropriate alarm stimulus, but which does not represent an attempt to intrude into the protected area.

##### 1.2.6.3 Environmental Alarm

An alarm during environmental conditions which exceed those specified.

##### 1.2.6.4 False Alarm

An alarm when there is no alarm stimulus.

##### 1.2.6.5 Duress Alarm

An alarm condition which results from a set of pre-established conditions such as entering a special code into a keypad or by activating a switch. This alarm category shall take precedence over other alarm categories.

##### 1.2.6.6 Fail-Safe Alarm

An alarm resulting from detection of diminished functional capabilities.

##### 1.2.6.7 Power Loss Alarm

An alarm resulting from a loss of primary power.

##### 1.2.6.8 Entry Control Alarm

An alarm resulting from improper use of entry control procedures or equipment.

##### 1.2.6.9 Identifier

A card credential, keypad personal identification number or code, biometric characteristic or any other unique identification entered as data into the entry control database for the purpose of identifying an individual. Identifiers shall be used by the electronic security system for the purpose of validating passage requests for areas equipped with entry control

equipment.

#### 1.2.6.10 Entry Control Devices

Any equipment which gives a user the means to input identifier data into the entry control system for verification.

#### 1.2.6.11 Facility Interface Device

A facility interface device shall be any type of mechanism which is controlled in response to passage requests and allows passage through a portal.

#### 1.2.7 Probability of Detection

Each zone shall have a continuous probability of detection greater than 90 percent and shall be demonstrated with a confidence level of 95 percent. This probability of detection is defined as 49 successful detections out of 50 tests or 96 successful detections out of 100 tests.

#### 1.2.8 Standard Intruder

The system shall be able to detect an intruder that weighs 100 pounds or less and is 5 feet tall or less. The intruder shall be dressed in a long-sleeved shirt, slacks and shoes unless environmental conditions at the site require protective clothing.

##### 1.2.8.1 Standard Intruder Movement

Standard intruder movement is defined as any movement such as walking, running, crawling, rolling, or jumping through a protected zone in the most advantageous manner for the intruder.

#### 1.2.9 False Alarm Rate

##### 1.2.9.1 Interior

A false alarm rate of no more than 1 false alarm per sensor per 30 days at the specified probability of detection shall be provided.

##### 1.2.9.2 Exterior

A false alarm rate of no more than 1 false alarm per sensor per 5 days at the specified probability of detection shall be provided.

#### 1.2.10 Error and Throughput Rates

Error and throughput rates shall be single portal performance rates obtained when processing individuals 1 at a time.

##### 1.2.10.1 Type I Error Rate

Type I error rate is defined as an error where the system denies entry to an authorized, enrolled individual. The rate shall be less than 1 percent.

##### 1.2.10.2 Type II Error Rate

Type II error rate is defined as an error where the system grants entry to an unauthorized individual. The entry control Type II error rate shall be

less than 0.1 percent.

#### 1.2.11 System Throughput

At the specified error rates, the system throughput rate through a single portal shall be as shown.

#### 1.2.12 Passage

Passage is defined as ingress and/or egress past an entry control device, or through a portal. Entry control procedures and equipment shall be implemented for passage through each portal as shown.

#### 1.2.13 Detection Resolution

The system shall have detection resolution sufficient to locate intrusions at each device and zone; and tampering at individual devices.

#### 1.2.14 Electrical Requirements

Electrically powered Card Access System equipment shall operate on 120 volt 60 Hz ac sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

#### 1.2.15 System Reaction

##### 1.2.15.1 System Response

The field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the central station within 1 second of the alarm occurring at a local processor or device controlled by a local processor, and within 100 milliseconds if the alarm occurs at the central station. Alarm and status changes shall be displayed within 100 milliseconds after receipt of data by the central station. All graphics shall be displayed, including graphics generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

##### 1.2.15.2 System Heavy Load Definition

For the purpose of system heavy load definition, the system shall consist of central station equipment, communication controller and required local processors. System heavy load conditions are defined as the occurrence of alarms at the rate of 10 alarms per second distributed evenly among all local processors in the system. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second.

#### 1.2.16 Environmental Conditions

##### 1.2.16.1 Interior, Controlled Environment

System components, except the console equipment installed in interior locations, having controlled environments shall be rated for continuous operation under ambient environmental conditions of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.

#### 1.2.16.2 Interior, Uncontrolled Environment

System components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 0 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.

#### 1.2.16.3 Exterior Environment

System components that are installed in locations exposed to weather shall be rated for continuous operation under ambient environmental conditions of minus 30 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, condensing. In addition, the system components shall be rated for continuous operation when exposed to performance conditions as specified in UL 294 and UL 639 for outdoor use equipment. Components shall be rated for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 2 feet thick, measured vertically.

#### 1.2.16.4 Console

Console equipment, unless designated otherwise, shall be rated for continuous operation under ambient environmental conditions of 60 to 85 degrees F and a relative humidity of 20 to 80 percent.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

System Drawings; G, RE

#### SD-03 Product Data

Manufacturer's Data; G, RE  
System Description and Analyses; G, RE  
Software Data; G, RE  
Graphics; G, RE

#### SD-05 Design Data

Overall System Reliability Calculations; G, RE

#### SD-06 Test Reports

Test Reports; G, RE

#### SD-07 Certificates

Certifications; G, RE

#### SD-08 Manufacturer's Instructions

Training Documentation; G, RE

## SD-10 Operation and Maintenance Data

Data Entry; G, RE  
Manuals; G, RE  
Functional Design Manual; G, RE  
Hardware Manual; G, RE  
Software Manual; G, RE  
Operator's Manual; G, RE  
Maintenance Manual; G, RE

## SD-11 Closeout Submittals

Final System Drawings; G, RE

## 1.4 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

All items of computer software and technical data (including technical data which relates to computer software), which is specifically identified in this specification shall be delivered to the Government. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

## 1.4.1 Technical Data Package

## 1.4.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. Console installation, block diagrams, and wiring diagrams.
- c. Local processor installation, typical block, and wiring diagrams.
- d. Local processor physical layout and schematics.
- e. Device wiring and installation drawings.
- f. Details of connections to power sources, including power supplies and grounding.
- g. Sensor detection patterns.

## 1.4.2 Manufacturer's Data

The data package shall include manufacturer's data for all materials and equipment, including terminal devices, local processors and central station equipment provided under this specification.

## 1.4.2.1 System Description and Analyses

The data package shall include system descriptions, analyses, and calculations used in sizing equipment specified. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Central processor memory size.

- b. Communication speeds and protocol descriptions.
- c. Hard disk size and configuration.
- d. Floppy disk size and configuration.
- e. Alarm response time calculations.
- f. Command response time calculations.
- g. Start-up operations.
- h. Expansion capability and method of implementation.
- i. Sample copy of each report specified.
- j. Color photographs representative of typical graphics.
- k. System throughput calculation.

#### 1.4.2.2 Software Data

The software data package shall consist of descriptions of the operation and capability of system, and application software as specified.

#### 1.4.3 Overall System Reliability Calculations

The overall system reliability calculations data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability in accordance with paragraph, OVERALL SYSTEM RELIABILITY REQUIREMENTS.

#### 1.4.4 Test Reports

- a. The Contractor shall prepare test procedures and reports for the pre-delivery test.
- b. The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval.

#### 1.4.5 Certifications

Specified manufacturer's certifications shall be included with the data package certification.

#### 1.4.6 Training Documentation

Lesson plans and training manuals for the training phases, including type of training to be provided, and a list of reference material, shall be delivered for approval.

#### 1.4.7 Data Entry

The Contractor shall enter all data needed to make the system operational. The Contractor shall deliver the data to the Government on data entry forms, utilizing data from the contract documents, Contractor's field

surveys, and other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify and request from the Government, any additional data needed to provide a complete and operational Card Access System. The completed forms shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.4.8 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install the graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the Government, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 x 10 inches in size, of each type of graphic to be used for the completed system. The graphics examples shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.4.9 Manuals

Final copies of the manuals as specified, bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representative for each item of equipment. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include modifications made during installation, checkout, and acceptance.

##### 1.4.9.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

##### 1.4.9.2 Hardware Manual

A manual describing all equipment furnished including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. System schematics and layout drawings.
- e. Alignment and calibration procedures.



- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.4.9.3 Software Manual

The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

- a. Definition of terms and functions.
- b. Use of system and applications software.
- c. Procedures for system initialization, start-up and shutdown.
- d. Alarm reports.
- e. Reports generation.
- f. Data base format and data entry requirements.
- g. Directory of all disk files.
- h. Description of all communication protocols, including data formats, command characters, and a sample of each type of data transfer.

#### 1.4.9.4 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:

- a. Computers and peripherals.
- b. System start-up and shutdown procedures.
- c. Use of system, and applications software.
- d. Recovery and restart procedures.
- e. Graphic alarm presentation.
- f. Use of report generator and generation of reports.
- g. Data entry.
- h. Operator commands.
- i. Alarm and system messages and printing formats.
- j. System entry requirements.

#### 1.4.9.5 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.4.9.6 Final System Drawings

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the system to be used for final system drawings. This set shall be accurately kept up-to-date by the Contractor with all changes and additions to the Card Access System and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Final drawings submitted with the endurance test report shall be finished drawings on vellum and CD-ROM.

### 1.5 TESTING

#### 1.5.1 General

The Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed Card Access System. The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test; notice shall not be given until after the Contractor has received written approval of the specific test procedures.

#### 1.5.2 Test Procedures and Reports

Test procedures shall explain in detail, step-by-step actions and expected results, demonstrating compliance with the requirements specified. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

### 1.6 TRAINING

#### 1.6.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the system as specified. The training shall be oriented to the specific system being installed. Training manuals shall be delivered for each trainee with 2 additional copies delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audio-visual equipment and other training materials and supplies. Where the Contractor presents portions of the course by audio-visual material, copies of the audio-visual material shall be delivered to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is defined as 8 hours of classroom instruction, including 2 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with Card Access System. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

#### 1.6.2 Operator's Training I

The first course shall be taught at the project site for a period of 5 consecutive training days at least 3 months prior to the scheduled

performance verification test. A maximum of 12 personnel shall attend this course. Upon completion of this course, each student, using appropriate documentation, shall be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

- a. General System hardware architecture.
- b. Functional operation of the system.
- c. Operator commands.
- d. Data base entry.
- e. Reports generation.
- f. Alarm reporting.
- g. Diagnostics.

#### 1.6.3 Operator's Training II

The second course shall be taught at the project site for a period of 5 consecutive training days during or after the Contractor's field testing, but before commencing the performance verification test. A maximum of 12 personnel shall attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system. Upon completion of this course, each student shall be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system.

#### 1.6.4 System Manager Training

4 system managers shall be trained for at least 1 day. The system manager training shall consist of the operator's training and the following:

- a. Enrollment/disenrollment.
- b. Assignments of identifier data.
- c. Assign operator password/levels.
- d. Change database configuration.
- e. Modify graphics.
- f. Print special or custom reports.
- g. System backup.
- h. Any other functions necessary to manage the system.

#### 1.6.5 Maintenance Personnel Training

The system maintenance course shall be taught at the project site after completion of the endurance test for a period of 1 training day. A maximum

of 5 personnel, designated by the Government, will attend the course. The training shall include:

- a. Physical layout of each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventive maintenance procedures and schedules.
- e. Calibration procedures. Upon completion of this course, the students shall be fully proficient in the maintenance of the system.

## 1.7 LINE SUPERVISION

### 1.7.1 Signal and Data Transmission System (DTS) Line Supervision

All signal and DTS lines shall be supervised by the system. The system shall supervise the signal lines by monitoring the circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment. The system shall initiate an alarm in response to a current change of 10 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTS lines.

### 1.7.2 Data Encryption

The system shall incorporate data encryption equipment on data transmission circuits as shown. The algorithm used for encryption shall be the Data Encryption Standard (DES) algorithm described in ANSI INCITS 92.

## 1.8 MAINTENANCE AND SERVICE

### 1.8.1 Warranty Period

The Contractor shall provide services required and equipment necessary to maintain the entire system in an operational state as specified, for a period of 1 year after formal written acceptance of the system, and shall provide necessary material required for performing scheduled adjustments or other nonscheduled work.

### 1.8.2 Description of Work

The adjustment and repair of the system includes all computer equipment, software updates, communications transmission equipment and DTS, local processors, sensors and entry control, facility interface, and support equipment. Responsibility shall be limited to Contractor installed equipment. The manufacturer's required adjustments and other work as necessary shall be provided.

### 1.8.3 Personnel

Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any change in personnel.

#### 1.8.4 Schedule of Work

The Contractor shall perform 2 minor inspections at 6 month intervals (or more often if required by the manufacturer), and 2 major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

##### 1.8.4.1 Minor Inspections

Minor inspections shall include visual checks and operational tests of console equipment, peripheral equipment, local processors, sensors, and electrical and mechanical controls. Minor inspections shall also include mechanical adjustments, new ribbons, and other necessary adjustments on printers.

##### 1.8.4.2 Major Inspections

Major inspections shall include work described under paragraph Minor Inspections and the following work:

- a. Clean all system equipment and local processors, including interior and exterior surfaces.
- b. Perform diagnostics on all equipment.
- c. Check, walk test, and calibrate each sensor.
- d. Run all system software diagnostics and correct all diagnosed problems.
- e. Resolve any previous outstanding problems.
- f. Purge and compress data bases.

##### 1.8.4.3 Scheduled Work

Scheduled work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

#### 1.8.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within 2 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.

#### 1.8.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable tests of the performance verification test.

#### 1.8.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system

chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.

#### 1.8.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

#### 1.8.9 Software

The Contractor shall provide a description of all software updates to the Government, who will then decide whether or not they are appropriate for implementation. After notification by the Government, the Contractor shall implement the designated software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with system operators, and shall be incorporated into the operation and maintenance manuals, and software documentation. There shall be at least 1 scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Contractor's software.

### PART 2 PRODUCTS

#### 2.1 MATERIALS REQUIREMENTS

##### 2.1.1 Materials and Equipment

Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place. System equipment shall conform to UL 294 and UL 1076.

##### 2.1.2 Field Enclosures

###### 2.1.2.1 Interior Sensor

Sensors to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.

###### 2.1.2.2 Exterior Sensor

Sensors to be used in an exterior environment shall be housed in an enclosure that provides protection against windblown dust, rain and splashing water, and hose directed water. Sensors shall be undamaged by the formation of ice on the enclosure.

#### 2.1.2.3 Interior Electronics

System electronics to be used in an interior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 12.

#### 2.1.2.4 Exterior Electronics

System electronics to be used in an exterior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 4X.

#### 2.1.2.5 Corrosion Resistant

System electronics to be used in a corrosive environment as defined in NEMA 250 shall be housed in metallic enclosures which meet the requirements of NEMA 250 Type 4X.

#### 2.1.3 Nameplates

Laminated plastic nameplates shall be provided for local processors. Each nameplate shall identify the local processor and its location within the system. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 x 3 inches, with minimum 1/4 inch high engraved block lettering. Nameplates shall be attached to the inside of the enclosure housing the local processor. Other major components of the system shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a corrosion resistant plate secured to the item of equipment. Nameplates will not be required for devices smaller than 1 x 3 inches.

#### 2.1.4 Tamper Provisions

##### 2.1.4.1 Tamper Switches

Enclosures, cabinets, housings, boxes, and fittings having hinged doors or removable covers and which contain circuits or connections of the system and its power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch shall function together and shall not allow direct line of sight to any internal components before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover; and shall be wired so that they break the circuit when the door or cover is disturbed.

a. Nonsensor Enclosures: Tamper switches on nonsensor enclosures which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

b. Sensor Enclosures: Tamper switches on sensor enclosures which must be opened to make routine maintenance adjustments to the sensor shall be provided.

#### 2.1.4.2 Enclosure Covers

Covers of pull and junction boxes provided to facilitate initial installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place or by tamper resistant security fasteners. Labels shall be affixed to such boxes indicating they contain no connections.

#### 2.1.5 Locks and Key-Lock Switches

##### 2.1.5.1 Locks

Locks shall be provided on system enclosures for maintenance purposes. Locks shall be UL listed, round-key type with 3 dual, 1 mushroom, 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be arranged so that the key can only be withdrawn when in the locked position. Maintenance locks shall be keyed alike and only 2 keys shall be furnished for all of these locks. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

##### 2.1.5.2 Key-Lock-Operated Switches

Key-lock-operated switches required to be installed on system components shall be UL listed, round-key type, with 3 dual, 1 mushroom, and 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be 2 position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only 2 keys shall be furnished for each key-lock-operated-switch. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

#### 2.1.6 System Components

System components shall be designed for continuous operation. Electronic components shall be solid state type, mounted on printed circuit boards conforming to UL 796. Printed circuit board connectors shall be plug-in, quick-disconnect type.

##### 2.1.6.1 Modularity

Equipment shall be designed for increase of system capability by installation of modular components. System components shall be designed to facilitate maintenance through replacement of modular subassemblies and parts.

##### 2.1.6.2 Maintainability

Components shall be designed to be maintained using commercially available tools and equipment. Components shall be arranged and assembled so they are accessible to maintenance personnel. There shall be no degradation in tamper protection, structural integrity, EMI/RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions. The system shall be configured and installed to yield a mean time to repair (MTTR) of not more than 8 hours. Repair time is the clock time from when maintenance personnel gain entrance to the



system and begin work, until the system is fully functional.

#### 2.1.6.3 Interchangeability

The system shall be constructed with off-the-shelf components which are physically, electrically and functionally interchangeable with equivalent components as complete items. Replacement of equivalent components shall not require modification of either the new component or of other components with which the replacement items are used. Custom designed or one-of-a-kind items shall not be used.

#### 2.1.6.4 Product Safety

System components shall conform to applicable rules and requirements of NFPA 70 and UL 294.

#### 2.1.7 Controls and Designations

Controls and designations shall be as specified in NEMA ICS 1.

#### 2.1.8 Special Test Equipment

The Contractor shall provide all special test equipment, special hardware, software, tools, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

### 2.2 CENTRAL STATION HARDWARE (CARD ACCESS SERVER)

The central station computer shall be a standard unmodified digital computer of modular design. The CPU word size shall be 64 bits or larger. The operating speed of the processor shall be at least 3 GHz.

#### 2.2.1 Memory

The computer shall contain at least 1000 megabytes of usable installed memory.

#### 2.2.2 Power Supply

The power supply shall have a minimum capacity of 400 Watts.

#### 2.2.3 Real Time Clock (RTC)

A RTC shall be provided. Accuracy shall be within plus or minus 1 minute per month. The RTC shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month and shall be resettable by software. The clock shall continue to function for a period of 1 year without power.

#### 2.2.4 Serial Ports

- a. Two EIA ANSI/EIA/TIA-232-F serial ports shall be provided for general use.
- b. Adjustable data transmission rates from 9600 to 57.6 Kbps shall be selectable under program control.

c. Four USB 2.0 ports.

#### 2.2.5 Parallel Port

An enhanced parallel port shall be provided.

#### 2.2.6 Color Monitor

The monitor shall be no less than 17 inches, flat panel, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. The video card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

#### 2.2.7 Keyboard A101

A keyboard having a minimum 64 character, standard ASCII character, based on ANSI INCITS 154 shall be furnished.

#### 2.2.8 Enhancement Hardware

Enhancement hardware such as special function keyboards, special function keys, touch screen devices, or mouse shall be provided for frequently used operator commands such as: Help, Alarm Acknowledge, Place Zone In Access, Place Zone In Secure, System Test, Print Reports, Change Operator, Security Lighting Controls, and Display Graphics.

#### 2.2.9 Disk Storage

A hard disk with controller having a maximum average access time of 10 milliseconds shall be provided. The hard disk shall provide a minimum of 200 gigabytes of formatted storage. Additionally, a hard disk slot with a removable 100 gigabyte hard drive shall be provided.

#### 2.2.10 Floppy Disk Drives

A high density floppy disk drive and controller in 3-1/2 inch size shall be provided.

#### 2.2.11 Modem

A modem shall be provided and operate at 56.6K bps, full duplex on circuits using asynchronous communications.

#### 2.2.12 Audible Alarm

The manufacturer's standard audible alarm shall be provided.

#### 2.2.13 Mouse

An optical mouse with a minimum resolution of 400 dots per inch shall be provided.

#### 2.2.14 CD-ROM Drive

A CD-ROM drive having a nominal storage capacity of 650 megabytes shall be provided.

#### 2.2.15 Alarm Printer

A dot matrix alarm printer shall be provided and interconnected to the central station equipment. The dot matrix alarm printer shall have a minimum 96 character, standard ASCII character set, based on ANSI INCITS 154 and with graphics capability. The printer shall be able to print in both red and black without ribbon change. The printers shall have adjustable sprockets for paper width up to 11 inches, print at least 80 columns per line and have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per inch. The printers shall utilize sprocket-fed fan fold paper. The units shall have programmable control of top-of-form. Twenty-five thousand sheets of printer paper and 12 ribbons shall be provided after successful completion of the testing.

#### 2.2.16 Controllers

Controllers required for operation of specified peripherals, serial, and parallel ports shall be provided.

#### 2.2.17 Uninterruptible Power Supply (UPS)

A self contained UPS, suitable for installation and operation at the central station, shall be provided. The UPS shall be sized to provide a minimum of 15 minutes of operation of the central station equipment. Equipment connected to the UPS shall not be affected by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.

### 2.3 CENTRAL STATION SOFTWARE

Software shall support all specified functions. The central station shall be online at all times and shall perform required functions as specified. Software shall be resident at the central station and/or the local processor as required to perform specified functions.

#### 2.3.1 System Software

System software shall perform the following functions:

- a. Support multiuser operation with multiple tasks for each user.
- b. Support operation and management of peripheral devices.
- c. Provide file management functions for disk I/O, including creation and deletion of files, copying files, a directory of all files including size and location of each sequential and random ordered record.
- d. Provide printer spooling.

#### 2.3.2 Real Time Clock Synchronization

The system shall synchronize each real time clock within 1 second and at least once per day automatically, without operator intervention and without requiring system shutdown.

### 2.3.3 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all parameters and constraints associated with each sensor, commandable output, zone, facility interface device, terminal device, etc. Each database item shall be callable for display or printing, including EPROM, ROM and RAM resident data. The database shall be defined and entered into the Card Access System by the Contractor based upon input from the Government.

### 2.3.4 Software Tamper

The Card Access System shall annunciate a tamper alarm when unauthorized changes to the system database files are attempted. Three consecutive unsuccessful attempts to log onto the system shall generate a software tamper alarm. A software tamper alarm shall also be generated when an operator or other individual makes 3 consecutive unsuccessful attempts to invoke central processor functions beyond their authorization level. The Card Access System shall maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. The system shall not allow write access to the system transcript files by any person, regardless of their authorization level. The system shall only allow acknowledgment of software tamper alarms and read access to the system transcript files by operators and managers with the highest password authorization level available in the system.

### 2.3.5 Application Software

The application software shall provide the interface between the alarm annunciation and entry control local processors; monitor all sensors and DTS links; operate displays; report alarms; generate reports; and assist in training system operators.

#### 2.3.5.1 Operator Commands

The operator's commands shall provide the means for entry of monitoring and control commands, and for retrieval of system information. Processing of operator commands shall commence within 1 second of entry, with some form of acknowledgment provided at that time. The operator's commands shall perform tasks including:

- a. Request help with the system operation.
- b. Acknowledge alarms.
- c. Place zone in access.
- d. Place zone in secure.
- e. Test the system.
- f. Generate and format reports.
- g. Print reports.
- h. Change operator.
- i. Control security lighting.

j. Request any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.

k. Entry control functions.

#### 2.3.5.2 Command Input

Operator's commands shall be full English language words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator in English word, phrase, or acronym. Commands shall be available in an abbreviated mode, in addition to the full English language (words and acronyms) commands, allowing an experienced operator to disregard portions, or all, of the prompt-response requirements.

#### 2.3.5.3 Command Input Errors

The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator, in English words and phrases, why the command cannot be executed. Error responses requiring an operator to look up a code in a manual or other document will not be accepted. Conditions for which operator error assist messages shall be generated include:

- a. The command used is incorrect or incomplete.
- b. The operator is restricted from using that command.
- c. The command addresses a point which is disabled or out of service.
- d. The command addresses a point which does not exist.
- e. The command would violate constraints.

#### 2.3.5.4 Enhancements

The system shall implement the following enhancements by use of special function keys, touch screen, or mouse, in addition to all other command inputs specified:

a. Help: Used to produce a display for all commands available to the operator. The help command, followed by a specific command shall produce a short explanation of the purpose, use, and system reaction to that command.

b. Acknowledge Alarms: Used to acknowledge that the alarm message has been observed by the operator.

c. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. The system shall be structured so that tamper circuits cannot be disabled by the console operator.

d. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.

e. System Test: Allows the operator to initiate a system wide operational test.

- f. Zone Test: Allows the operator to initiate an operational test for a specific zone.
- g. Print Reports: Allows the operator to initiate printing of reports.
- h. Change Operator: Used for changing operators.
- i. Security Lighting Controls: Allows the operator to remotely turn on/off security lights.
- j. Display Graphics: Used to display any graphic displays implemented in the system.

#### 2.3.5.5 System Access Control

The system shall provide a means to define system operator capability and functions through multiple, password protected operator levels. At least 3 operator levels shall be provided. System operators and managers with appropriate password clearances shall be able to change operator levels for all operators. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm. A minimum of 32 passwords shall be usable with the system software. The system shall display the operator's name or initials in the console's first field. The system shall print the operator's name or initials, action, date, and time on the system printer at log-on and log-off. The password shall not be displayed or printed. Each password shall be definable and assignable for the following:

- a. Commands usable.
- b. Access to system software.
- c. Access to application software.
- d. Individual zones which are to be accessed.
- e. Access to database.

#### 2.3.5.6 Alarm Monitoring Software

This program shall monitor all sensors, local processors and DTS circuits and notify the operator of an alarm condition. Alarms shall be printed in red on the alarm printer and displayed on the console's text monitors. Higher priority alarms shall be displayed first; and within alarm priorities, the oldest unacknowledged alarm shall be displayed first. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Alarm data to be displayed shall include type of alarm, location of alarm, and secondary alarm messages. Alarm data to be printed shall include: type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator response. A unique message field with a width of 60 characters shall be provided for each alarm. Assignment of messages to a zone or sensor shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator. The system shall provide for 25 secondary messages with a field of 4 lines of 60 characters each. The most recent 1000 alarms shall be stored and shall be recallable by the operator using the report generator.

#### 2.3.5.7 Monitor Display Software

Monitor display software shall provide for text displays that include zone status integrated into the display. Different colors shall be used for the various components and real time data. Colors shall be uniform on all displays. The following color coding shall be followed.

- a. FLASHING RED to alert an operator that a zone has gone into an alarm or that primary power has failed.
- b. RED to alert an operator that a zone is in alarm and that the alarm has been acknowledged.
- c. YELLOW to advise an operator that a zone is in access.
- d. GREEN to indicate that a zone is secure or that power is on.

#### 2.3.5.8 Map Displays/Graphics Linked to Alarms

The System shall relate map displays or other graphics to alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the map display or graphic related to the alarm shall be automatically displayed. The definition of which maps or graphics shall be displayed with each alarm shall be selectable by system operators through simple menu choices as part of the system initial configuration.

#### 2.3.5.9 User Defined Prompts/Messages Linked to Alarms

The System shall provide a means to relate operator defined prompts and other messages to predefined alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the prompts or messages related to the alarm shall be automatically displayed.

#### 2.3.5.10 System Test Software

This software shall enable the operator to initiate a test of the system. This test can be of the entire system or of a particular portion of the system at the operator's option. The results of each test shall be stored for future display or print out in report form.

#### 2.3.5.11 Report Generator

Software shall be provided with commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time and shall be printed on the report printer. Reports shall be spooled, allowing the printing of one report to be complete before the printing of another report commences. The dynamic operation of the system shall not be interrupted to generate a report. The report generation mode, either periodic, automatic or on request, shall be operator selectable. The report shall contain the time and date when the report was printed, and the name of operator generating the report. The exact format of each report type shall be operator configurable.

- a. Periodic Automatic Report Modes: The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

b. Request Report Mode: The system shall allow the operator to request at any time an immediate printout of any report.

c. Alarm Report: The alarm report shall include all alarms recorded by the system over an operator selectable time. The report shall include such information as: the type of alarm (intrusion, tamper, etc.); the type of sensor; the location; the time; and the action taken.

d. System Test Report: This report documents the operational status of all system components following a system test.

e. Access/Secure Report: This report documents all zones placed in access, the time placed in access, and the time placed in secure mode.

f. Entry Control Reports: The system shall generate hard copy reports of identifier, terminal, and guard tour tracking reports, and versions with defined parameters of the manufacturer's standard management and activity reports.

#### 2.3.5.12 Simulation (Training) Software

This program shall enable operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. The system shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

#### 2.3.5.13 Entry Control Enrollment Software

The enrollment station shall provide database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed. The enrollment station shall not have any alarm response or acknowledgment functions. Multiple, password protected access levels shall be provided at the enrollment station. Database management and modification functions shall require a higher operator access level than personnel enrollment functions. The program shall provide a means for disabling the enrollment station when it is unattended to prevent unauthorized use. The program shall provide a method to enter personnel identifying information into the entry control database files through enrollment stations. In the case of personnel identity verification subsystems, this data shall include biometric data. The program shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs. All personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry control database files.

### 2.4 FIELD PROCESSING HARDWARE

#### 2.4.1 Entry Control Local Processor (Card Reader Access Controller)

The entry control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station and change outputs based on commands received from the central station. The local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs. The entry control local processor shall provide local



entry control functions including communicating with field devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators and exit pushbuttons. The processor shall also accept data from entry control field devices as well as database downloads and updates from the central station that include enrollment and privilege information. The processor shall also send indications of success or failure of attempts to use entry control field devices and make comparisons of presented information with stored identification information. The processor shall grant or deny entry by sending control signals to portal control devices and mask intrusion alarm annunciation from sensors stimulated by authorized entries. The entry control local processor shall use inputs from entry control devices to change modes between access and secure. The local processor shall maintain a date-time and location stamped record of each transaction and transmit transaction records to the central station. The processor shall operate as a stand-alone portal controller using the downloaded data base during periods of communication loss between the local processor and the field device network. The processor shall store up to 1000 transactions during periods of communication loss between the local processor and the field device network for subsequent upload to the central station upon restoration of communication. The local processor shall provide power for field devices and portal control devices.

- a. Inputs. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions. The local processor shall have at least 8 alarm inputs which allow wiring as normally open or normally closed contacts for alarm conditions. It shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements. The local processor shall report line supervision alarms to the central station. Alarms shall be reported for any condition that remains off normal at an input for longer than 500 milliseconds. Each alarm condition shall be transmitted to the central station during the next interrogation cycle. The entry control local processor shall include the necessary software drivers to communicate with entry control field devices. Information generated by the entry control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges. Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time and location stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
- b. Outputs. Local processor outputs shall reflect the state of commands issued by the central station. The outputs shall be a form C contact and shall include normally open and normally closed contacts. The local processor shall have at least 4 commandable outputs. The entry control local processor shall also provide control outputs to portal control devices.
- c. Degraded Mode of Operation. The entry control local processor

shall provide a degraded mode of operation for periods when communication between the local processor and the field device network is lost. While in this degraded mode, the local processor shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal control devices. Transactions shall be stored for subsequent transmission to the central station when communication is restored.

- d. Fiber Optic Modems: Provide fiber optic modems for components communicating between card access controller and host to fiber. Modems shall communicate using 62.4 nm/125 nm, multimode fiber optic cable. Provide all necessary fiber optic jumpers. Jumpers shall have ST connectors.

#### 2.4.1.1 Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 4 hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa. All card readers, magnetic locks, etc., shall be fully functional when local processor is on battery. Batteries shall be sealed, non-outgassing type. The power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.

### 2.5 FIELD PROCESSING SOFTWARE

All Field processing software described in this specification shall be furnished as part of the complete system.

#### 2.5.1 Operating System

Each local processor shall contain an operating system that controls and schedules that local processor's activities in real time. The local processor shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that local processor. The execution of local processor application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each local processor real time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds. The time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown.

##### 2.5.1.1 Startup

The local processor shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected Input/Output functions. A local processor restart program based on detection of power failure at the local processor shall be included in the local processor software. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the

database and application programs are resident, the local processor shall immediately resume operation.

#### 2.5.1.2 Operating Mode

Each local processor shall control and monitor inputs and outputs as specified, independent of communications with the central station. Alarms, status changes and other data shall be transmitted to the central station when communications circuits are operable. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station shall be stored for later transmission to the central station. Storage for the latest 1024 events shall be provided at each local processor. Each local processor shall accept software downloaded from the central station.

#### 2.5.1.3 Failure Mode

Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

#### 2.5.2 Functions

The Contractor shall provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each local processor.

- a. Monitoring of inputs.
- b. Control of outputs.
- c. Reporting of alarms automatically to the central station.
- d. Reporting of sensor and output status to central station upon request.
- e. Maintenance of real time, automatically updated by the central station at least once a day.
- f. Communication with the central station.
- g. Execution of local processor resident programs.
- h. Diagnostics.
- i. Download and upload data to and from the central station.

#### 2.6 INTERIOR SENSORS AND CONTROL DEVICES

##### 2.6.1 Balanced Magnetic Switch (BMS)

The BMS shall detect a 1/4 inch of separating relative movement between the magnet and the switch housing. Upon detecting such movement, the BMS shall transmit an alarm signal to the alarm annunciation system.

#### 2.6.1.1 BMS Subassemblies

The BMS shall consist of a switch assembly and an actuating magnet assembly. The switch mechanism shall be of the balanced magnetic type. Each switch shall be provided with an overcurrent protective device, rated to limit current to 80 percent of the switch capacity. Switches shall be rated for a minimum lifetime of 1,000,000 operations. The magnet assembly shall house the actuating magnet.

#### 2.6.1.2 Housing

The housings of surface mounted switches and magnets shall be made of nonferrous metal and shall be weatherproof. The housings of recess mounted switches and magnets shall be made of nonferrous metal or plastic.

#### 2.6.2 Duress Alarm Switches

Duress alarm switches shall provide the means for an individual to covertly notify the alarm annunciation system that a duress situation exists.

##### 2.6.2.1 Push-button

Latching push-button duress alarm switches shall be designed to be activated by depressing a push-button located on the duress switch housing. No visible or audible alarm or noise shall emanate from the switch. The switch housing shall shroud the activating button to prevent accidental activation. Switches shall be rated for a minimum lifetime of 50,000 operations.

#### 2.6.3 Passive Infrared Motion Sensor

The passive infrared motion sensor shall detect changes in the ambient level of infrared emissions caused by the movement of a standard intruder within the sensor's field of view. Upon detecting such changes, the sensor shall transmit an alarm signal to the alarm annunciation system. The sensor shall detect a change in temperature of no more than 2.5 degrees F, and shall detect a standard intruder traveling within the sensor's detection pattern at a speed of 0.3 to 7.5 feet per second across 2 adjacent segments of the field of view. Emissions monitored by the sensor shall be in the 8 to 14 micron range. The sensor shall be adjustable to obtain barrier 360 degree coverage patterns. Sensor shall have a 60 feet range with 12 segments. The sensor shall be equipped with a temperature compensation circuit.

##### 2.6.3.1 Test Indicator, Passive Infrared

The passive infrared motion sensor shall be equipped with an LED walk test indicator. The walk test indicator shall not be visible during normal operations. When visible, the walk test indicator shall light when the sensor detects an intruder. The sensor shall either be equipped with a manual control, located within the sensor's housing, to enable/disable the test indicator or the test indicator shall be located within the sensor housing so that it can only be seen when the housing is open or removed.

#### 2.7 ENTRY CONTROL DEVICES

##### 2.7.1 Card Readers and Credential Cards

Entry control card readers shall use unique coded data stored in or on a

compatible credential card as an identifier. The card readers shall be proximity type, and shall incorporate built-in heaters or other cold weather equipment to extend the operating temperature range as needed for operation at the site. Communications protocol shall be compatible with the local processor. The Contractor shall furnish card readers to read internal identification chip entry cards, and the matching credential cards. The cards shall contain coded data arranged as a unique identification code stored on or within the card, and of the type readable by the card readers. The Contractor shall include within the card's encoded data, a non-duplicated unique facility identification code common to all credential cards provided at the site. Enrollment equipment to support local encoding of badges including cryptographic and other internal security checks shall be supplied.

#### 2.7.1.1 Proximity

Proximity card readers shall use passive proximity detection and shall not require contact with the proximity credential card for proper operation. Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number. The card reader shall read proximity cards in a range from 0 inches to at least 6 inches from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.

#### 2.7.1.2 Card Reader Display

The card readers shall include an LED or other visual indicator display. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

#### 2.7.1.3 Card Reader Response Time

The card reader shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less, from the time the card reader finishes reading the credential card until a response signal is generated.

#### 2.7.1.4 Card Reader Mounting Method

Card readers shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

#### 2.7.1.5 Credential Card

Entry control cards shall be able to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge as need for the site without reduction of readability.

The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type badge holder used at the site.

#### 2.7.1.6 Card Size and Dimensional Stability

Credential cards shall be 2-1/8 x 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

#### 2.7.1.7 Card Materials and Physical Characteristics

The credential card shall be abrasion resistant, non-flammable, and present no toxic hazard to humans when used in accordance with manufacturer's instructions. The credential card shall be impervious to solar radiation and the effects of ultra-violet light.

#### 2.7.1.8 Card Construction

The credential card shall be of core and laminate or monolithic construction. Lettering, logos and other markings shall be hot stamped into the credential material or direct printed. The Contractor shall provide a means to allow onsite assembly and lamination of credential cards by Government personnel. Provide all necessary printers, laminator, etc., for onsite assembly of cards.

#### 2.7.1.9 Card Durability and Maintainability

The credential cards shall be designed and constructed to yield a useful lifetime of at least 5000 insertions or swipes or 5 years, whichever results in a longer period of time. The credential card shall be able to be cleaned by wiping the credential card with a sponge or cloth wet with a soap and water solution.

#### 2.7.1.10 Furnished Cards

Furnish 1000 credential cards to Government.

#### 2.7.2 Keypads

Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. Communications protocol shall be compatible with the local processor.

##### 2.7.2.1 Keypad Display

Keypads shall include an LED or other type of visual indicator display and provide visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

##### 2.7.2.2 Keypad Response Time

The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.

##### 2.7.2.3 Keypad Power

The keypad shall be powered from the local processor.

#### 2.7.2.4 Keypad Mounting Method

Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as shown.

#### 2.7.2.5 Keypad Duress Codes

Keypads shall provide a means for users to indicate a duress situation by entering a special code.

#### 2.7.3 Portal Control Devices

##### 2.7.3.1 Push-button Switches (Exit Button)

Provide momentary contact, back lighted push buttons and stainless steel switch enclosures for each push button as shown. Switch enclosures shall be suitable for flush mounting. Push button switch labeled with 1/4 inch high text and symbols as required. The push button switches shall be connected to the inputs of the local processor associated with the portal to which they are applied and shall operate the appropriate electric strike, electric bolt or other facility release device. Switches shall have a minimum continuous current rating of 10 Amperes at 120 Vac or 5 Amperes at 240 Vac.

##### 2.7.3.2 Remote Door Release Buttons

Provide momentary contact, back lighted push buttons and stainless steel switch enclosures. Switch enclosures shall be suitable for desk mounting. Multiple push buttons are housed within a single switch enclosure and shall be stacked vertically with each push button switch labeled with 1/4 inch high text and symbols as required. The push button switches shall be connected to the local processor associated with the portal to which they are applied and shall operate the appropriate electric strike, electric bolt or other facility release device. Switches shall have a minimum continuous current rating of 1 Amperes at 120 Vac. Provide 1/4 inch stainless steel cable from push button enclosure to wall box.

##### 2.7.3.3 Electromagnetic Lock (Electromagnetic Door Release)

Electromagnetic locks shall contain no moving parts and shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall release automatically in case of power failure and shall require manual reset to resume normal function. The lock shall interface with the local processors without external, internal or functional alteration of the local processor. The electromagnetic lock shall incorporate an end of line resistor to facilitate line supervision by the system.

a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 12 or 24 Volts dc and shall not dissipate more than 12 Watts. The holding current shall be not greater than 500 milliamperes. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.

c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware as shown, and shall be compatible with right or left hand mounting.

#### 2.7.3.4 Electromagnetic Lock With Delay Egress (Electromagnetic Door Release)

Electromagnetic locks shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall release automatically in case of power failure and shall require manual reset to resume normal function. The lock shall have an integral displacement sensor that when the door is pushed, initiates a non-reversible release of door within an adjustable 15 to 30 second delay period. The lock shall interface with the local processors without external, internal or functional alteration of the local processor.

The electromagnetic lock shall incorporate an end of line resistor to facilitate line supervision by the system.

a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 12 or 24 Volts dc. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.

c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware as shown, and shall be compatible with right or left hand mounting.

### 2.8 ENTRY CONTROL SOFTWARE

#### 2.8.1 Interface Device

The entry control software shall control passage. The decision to grant or deny passage shall be based upon identifier data to be input at a specific location. If all conditions are met, a signal shall be sent to the input device location to activate the appropriate electric strike, bolt, electromagnetic lock or other type of portal release or facility interface device.

#### 2.8.2 Operator Interface

Entry control operation shall be entirely automatic under control of the central station and local processors except for simple operations required for map display, alarm acknowledgment, zone and portal status change operations, audible or visual alarm silencing and audio annunciation. The system shall immediately annunciate changes in zone and portal status. The alarm printer shall print a permanent record of each alarm and status change. The map displays or graphics screens shall display the current status of system zones and portals. The central station shall immediately display the current status of any zone or portal upon command. While the system is annunciating an unacknowledged zone or portal alarm, keyboard operations at the central station, other than alarm acknowledgment, shall not be possible. The system shall provide the capability to change zone and portal status from alarm (after alarm acknowledgment) or access to secure; from alarm (after alarm acknowledgment) or secure to access, or



from access to secure by simple control operations. If the operator attempts to change zone status to secure while there is an alarm output for that zone or portal, the system shall immediately annunciate an alarm for that zone or portal.

### 2.8.3 Entry Control Functions

#### 2.8.3.1 Multiple Security Levels

The system shall have multiple security levels. Each of the security levels shall be delineated by facility barriers. Access to each security level shall be through portals in the facility barriers using designated entry control procedures. The system shall provide at least 8 security levels. Any attempt to access an area beyond an individual's security level shall initiate an access denial alarm.

#### 2.8.3.2 Two person rule

The system shall provide a 2 person rule feature. When a portal is designated as a 2 person rule portal, it shall not allow passage unless 2 valid identifiers are presented in the proper sequence. The scheme shall be designed so that only the first 2 valid identifiers and the last 2 valid identifiers pass together.

#### 2.8.3.3 Anti-Passback

Portals as shown shall incorporate anti-passback functions. Anti-passback functions and identifier tracking shall be system-wide for portals incorporating anti-passback. Once an authorized, enrolled individual has passed through a portal using entry control procedures, the system shall not allow use of the same identifier to pass through any portal at the same security level until the individual has egressed through a portal at this same security level using entry control procedures. Any attempt to violate anti-passback procedures shall initiate an access denial alarm. Portals that do not incorporate anti-passback functions shall allow egress from the area by a push-button switch for activation of the facility interface device. Portal egress switch shall be located as shown.

#### 2.8.3.4 Immediate Access Change

The system shall provide functions to disenroll and deny access to any identifier or combination of identifiers without consent of the individual or recovery of a credential. The design of the system shall provide entry change capability to system operators and managers with appropriate passwords at the system operator or enrollment consoles.

#### 2.8.3.5 Multiple Time Zones

The system shall provide multiple time zone entry control. Personnel enrolled in the system shall only be allowed access to a facility during the time of day they are authorized to access the facility. Time zone access control shall also include the ability to specify beginning and ending dates that an individual will be authorized to access a facility. The system shall provide automatic activation and deactivation of entry authorization. The design of the system shall provide at least 16 time zones with overlapping time zones. The system shall provide a means for system operators with proper password clearance, to define custom names for each time zone, and to change the time zone's beginning and ending times through the system operator and enrollment interfaces. The system shall

automatically disenroll individuals at the end of their predefined facility access duration. Any attempt during a 24 hour period by an individual or an identifier to gain facility entry outside of the authorized time zone shall initiate an entry denial alarm.

#### 2.8.4 Electronic Entry Control System Capacities

The system shall be designed and configured to provide the following capacities.

##### 2.8.4.1 Enrollees

The system shall be configured for 1000 enrollees. The system shall provide a facility-tailorable reference file database containing personal, access authorization, identifier and verification data for each enrollee as required.

##### 2.8.4.2 Transaction History File Size

The system capacity shall be at least the amount of transactions for the system during 1 year without any loss of transaction data.

#### 2.8.5 Entry Control System Alarms

The system shall annunciate an alarm when the following conditions occur. Alarms shall be annunciated at the console both audibly and visually. An alarm report shall also be printed on the system printer. The alarm annunciation shall continue until acknowledged by the system operator. Only 1 control key shall be needed to acknowledge an alarm. The system shall control, monitor, differentiate, rank, annunciate, and allow operators to acknowledge, in real time, alarm signals generated by system equipment. The system shall also provide a means to define and customize the annunciation of each alarm type. The system shall use audio and visual information to differentiate the various types of alarms. Each alarm type shall be assigned an audio and a unique visual identifier.

##### 2.8.5.1 Duress

The system shall annunciate a duress alarm when a duress code is entered at a keypad or a duress switch is activated. Duress alarms shall be annunciated in a manner that distinguishes them from all other system alarms. Duress alarms shall not be annunciated or otherwise indicated locally nor shall a duress alarm cause any special or unusual indications at the portal or area initiating the duress alarm. Individual privileges shall be carried out the same as an authorized entry to the protected area. Duress alarms shall only be annunciated at the central station and remote displays. Alarms shall be annunciated on the monitor and shall be logged on the printer.

##### 2.8.5.2 Entry Denial

The system shall annunciate an alarm when an attempt has been made to pass through a controlled portal and entry has been denied.

##### 2.8.5.3 Portal Open

The system shall annunciate an alarm when an entry controlled portal has been open longer than a predefined time delay. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1

minute with a maximum resolution of 1 second.

#### 2.8.5.4 Lock Not Secured

The system shall annunciate an alarm when the lock at an entry controlled portal has been left unsecured longer than a predefined time delay and generate an entry control alarm. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.8.5.5 Alarm Shunting/System Bypass

The system shall provide a means to ignore operator selected alarm types at operator selected portals in order to allow standard entry control procedures to be bypassed (shunted). Predefined alarm shunting shall only be available to system operators with the proper password. The system shall also provide for predefined alarm shunting based upon time zones. This capability shall only apply to the entry control alarm type.

### 2.9 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government furnished equipment. Wiring shall meet NFPA 70 standards.

#### 2.9.1 Above Ground Sensor Wiring

Sensor wiring shall be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Multiconductor wire shall have an outer jacket of PVC.

#### 2.9.2 Local Area Network (LAN) Cabling

LAN cabling shall be in accordance with EIA ANSI/TIA/EIA-568-A, category 6.

#### 2.9.3 Knox Box

Connect to knox box alarm switch furnished under the hardware trade. Coordinate installation and connection to knox box alarm switch with hardware trade.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

The Contractor shall install all system components, including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown. The contractor shall furnish necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

#### 3.1.1 Installation

The contractor shall install the system in accordance with the standards for safety, NFPA 70, UL 681, UL 1037 and UL 1076, and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate service points to pinpoint system

trouble in less than 20 minutes. Minimum size of conduit shall be 1/2 inch. DTS shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. Flexible cords or cord connections shall not be used to supply power to any components of the system, except where specifically noted. All other electrical work shall be as specified in Section 16415A, ELECTRICAL WORK, INTERIOR and as shown.

### 3.1.2 Enclosure Penetrations

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in a manner that does not damage the cable.

### 3.1.3 Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc., shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

### 3.1.4 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report any changes in the site, or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

### 3.1.5 Installation Software

The Contractor shall load software as specified and required for an operational system, including data bases and specified programs. Upon successful completion of the endurance test, the Contractor shall provide original and backup copies on CD-ROM of all accepted software, including diagnostics.

## 3.2 SYSTEM STARTUP

Satisfaction of the requirements below does not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment. The Contractor shall not apply power to the system until after:

- a. System equipment items and DTS have been set up in accordance with manufacturer's instructions.
- b. A visual inspection of the system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
- c. System wiring has been tested and verified as correctly connected.
- d. System grounding and transient protection systems have been

verified as properly installed.

e. Power supplies to be connected to the system have been verified as the correct voltage, phasing, and frequency.

### 3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed system; and are approved by the Contracting Officer. These representatives shall be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet the contractual requirements.

### 3.4 TESTING

#### 3.4.1 General Requirements for Testing

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during predelivery, performance verification and endurance testing, shall be turned over to the Government at the conclusion of each phase of testing, prior to Government approval of the test.

#### 3.4.2 Test Setup

The predelivery test setup shall include the following:

- a. All central station equipment.
- b. At least 1 of each type DTS link, but not less than 2 links, and associated equipment to provide a fully integrated system.
- c. The number of local processors shall equal the amount required by the site design.
- d. At least 1 of each type sensor used.
- e. Enough sensor simulators to provide alarm signal inputs to the system equal to the number of sensors required by the design. The alarm signals shall be manually or software generated.
- f. At least 1 of each type of terminal device used.
- g. At least 1 of each type of portal configuration with all facility interface devices as specified or shown.
- h. Equipment as specified in Section 16751A CLOSED CIRCUIT TELEVISION SYSTEMS when required.
- i. The Contractor shall prepare test procedures and reports for the predelivery test, and shall deliver the predelivery test procedures to the

Government for approval. The final predelivery test report shall be delivered after completion of the predelivery test.

#### 3.4.3 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTS operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations, including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

#### 3.4.4 Performance Verification Test

The Contractor shall demonstrate that the completed system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

The performance verification test, as specified, shall not be started until after receipt by the Contractor of written permission from the Government, based on the Contractor's written report. The report shall include certification of successful completion of testing as specified in paragraph Contractor's Field Testing, and upon successful completion of training as specified. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

### 3.5 RELIABILITY CALCULATION

This exponential calculation depends on the test duration and assumes that the Mean Time Between Failures (MTBF) does not change after each repair; and that the probability of failure is constant throughout the useful life of the component regardless of how many failures the system has experienced. This calculation does not account for effects of aging.

#### 3.5.1 Definition of Reliability

System reliability is calculated in terms of overall MTBF where the component reliability furnished by vendors is already expressed as MTBF. The mathematical combination of the component MTBF values is defined as the system reliability,  $R(t)$ ; the probability that the system will perform its function during a given time period under specified conditions. In this calculation, each component reliability is determined; the component reliabilities are combined as dictated by the system configuration; and the overall MTBF is computed as follows:

$R(t) = e^{(-t/MTBF)}$ ; where:

MTBF = mean time between failure

t = duration of test period

e = base of natural logarithms

When  $t/MTBF$  is less than 0.1, the reliability can be approximated as follows:

$R(t) = 1 - (t/MTBF)$ : A specific reliability value can be interpreted by noting that a value of  $R(t)$  greater than  $1/e$  (which equals 0.37) indicates that the MTBF value is greater than the test duration.

### 3.5.2 Series and Parallel Components

Components are in series if failure of 1 component causes a system failure.

Reliability of components in series is a product of the individual reliabilities:

$R = 1 - (r_1)(r_2)(r_3)...(r_n)$ . If components in a system are redundant (parallel), reliability is computed as follows:

$R = 1 - \{(1-r_1)(1-r_2)...(1-r_n)\}$ . If a system has parallel components, an equivalent series reliability is computed for each set of parallel components. The reliability of the system is then computed as the product of series and equivalent series reliabilities.

### 3.5.3 Calculation Procedure

The Contractor shall prepare a table showing the following data:

- a. Name and quantity of each component.
- b. Each component identified as series or parallel. (For example, if there are 2 printers, the failure of 1 will not cause a system failure).
- c. MTBF for each component.
- d. Single unit reliability:  $R = e(-t/MTBF)$ , where  $t = 1,000$  hour test period.
- e. Total Component Reliability (TCR) where  $TCR = R_n$ , and  $n$  = number of components. For parallel components,  $TCR = 1 - (1-R)^n$ , where  $n$  = number of components.
- f. Cumulative Reliability (CUMR) is the product of total component reliability; for example:  $CUMR_4 = (TCR_1)(TCR_2)(TCR_3)(TCR_4) = (CUMR_3)(TCR_4)$
- g. Cumulative MTBF =  $-1,000/LN(CUMR)$ ; where  $LN(CUMR)$  is the natural logarithm of (CUMR). As an example:  $CUM.MTBF = -1,000/LN(CUMR_4)$

### 3.5.4 Sample Calculations

MTBF is not calculated for sensors and controls. Input/Output functions are part of the local processor. Any Input/Output failure not attributable to sensors and controls constitutes a local processor failure and is thus reflected in the local processor MTBF. MTBF for other components are based on the lowest values provided by vendors. The calculation shall be based on the following configuration:

- a. All central station equipment.
- b. Data Transmission System (DTS) equipment associated with one DTS

circuit, but excluding the circuit itself.

c. Sixteen local processors with all the functions as specified in paragraph Local Processor.

d. Four representative types of devices, per local processor.

-- End of Section --



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## SECTION 13721A

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## SECTION 13721A

## CARD ACCESS SYSTEM - SCIF SYSTEM

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## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI INCITS 154 (1988; R 1999) Office Machines and  
Supplies - Alphanumeric Machines-Keyboards  
Arrangement

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/EIA/TIA-232-F (2002) Interface Between Data Terminal  
Equipment and Data Circuit-Terminating  
Equipment Employing Serial Binary Data  
Interchange

EIA ANSI/TIA/EIA-568-A (1995; Addendum 3 1998) Commercial  
Building Telecommunications Cabling  
Standard - 3 Parts

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE Std 142 (1992) IEEE Recommended Practice for  
Grounding of Industrial and Commercial  
Power Systems - Green Book

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NEMA ICS 1 (2001) Industrial Control and Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 294 (1999; Rev thru Oct 2001) Access Control

## System Units

UL 681	(1999; Rev thru Jan 2001) Installation and Classification of Burglar and Holdup Alarm Systems
UL 796	(1999; Rev thru Dec 2001) Printed-Wiring Boards
UL 1037	(1999) Antitheft Alarms and Devices
UL 1076	(1995; Rev thru Feb 1999) Proprietary Burglar Alarm Units and Systems
UL 2050	Standard for Safety of National Industrial Security Systems

## 1.2 SYSTEM DESCRIPTION

The Contractor shall provide a Card Access System as described. All equipment shall comply with UL 2050 and the installing Contractor shall be UL listed to install and service UL 2050 alarm systems. All materials shall be Defense Intelligence Agency (DIA) approved. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15. Electronic equipment shall comply with 47 CFR 15.

## 1.2.1 Central Station (Card Access Server)

The central station shall be configured to provide operator interface, interaction, dynamic and real time monitoring, display, and control. The central station shall control system networks to interconnect all system components including subordinate or separate control stations, enrollment stations and field equipment. The system shall be able to manage up to 16,000 uniquely identifiable inputs and outputs.

## 1.2.2 Field Device Network

The field device network shall provide communication between a central control station and field devices of the system. The field device network shall be configured as shown in the drawings. Field devices shall consist of alarm annunciation local processors and entry control local processors. Each field device shall be interrogated during each interrogation cycle. The field device network shall provide line supervision that detects and annunciates communications interruptions or compromised communications between any field device and the central station.

## 1.2.3 Field Equipment

Field equipment shall include local processors, sensors and controls. Local processors shall serve as an interface between the central station and sensors and controls. Data exchange between the central station and the local processors shall include down-line transmission of commands, software and databases to local processors. The up line data exchange from the local processor to the central station shall include status data such as intrusion alarms, status reports and entry control records. Local processors are categorized as alarm annunciation or entry control.

#### 1.2.4 System Definitions

##### 1.2.4.1 Intrusion Alarm

An alarm resulting from the detection of a specified target, caused by an attempt to intrude into the protected area, or when entry into an entry controlled area is attempted without successfully using entry control procedures.

##### 1.2.4.2 Nuisance Alarm

An alarm resulting from the detection of an appropriate alarm stimulus, but which does not represent an attempt to intrude into the protected area.

##### 1.2.4.3 Environmental Alarm

An alarm during environmental conditions which exceed those specified.

##### 1.2.4.4 False Alarm

An alarm when there is no alarm stimulus.

##### 1.2.4.5 Duress Alarm

An alarm condition which results from a set of pre-established conditions such as entering a special code into a keypad or by activating a switch. This alarm category shall take precedence over other alarm categories.

##### 1.2.4.6 Fail-Safe Alarm

An alarm resulting from detection of diminished functional capabilities.

##### 1.2.4.7 Power Loss Alarm

An alarm resulting from a loss of primary power.

##### 1.2.4.8 Entry Control Alarm

An alarm resulting from improper use of entry control procedures or equipment.

##### 1.2.4.9 Identifier

A card credential, keypad personal identification number or code, biometric characteristic or any other unique identification entered as data into the entry control database for the purpose of identifying an individual. Identifiers shall be used by the electronic security system for the purpose of validating passage requests for areas equipped with entry control equipment.

##### 1.2.4.10 Entry Control Devices

Any equipment which gives a user the means to input identifier data into the entry control system for verification.

##### 1.2.4.11 Facility Interface Device

A facility interface device shall be any type of mechanism which is controlled in response to passage requests and allows passage through a



portal.

#### 1.2.5 Probability of Detection

Each zone shall have a continuous probability of detection greater than 90 percent and shall be demonstrated with a confidence level of 95 percent. This probability of detection is defined as 49 successful detections out of 50 tests or 96 successful detections out of 100 tests.

#### 1.2.6 Standard Intruder

The system shall be able to detect an intruder that weighs 100 pounds or less and is 5 feet tall or less. The intruder shall be dressed in a long-sleeved shirt, slacks and shoes unless environmental conditions at the site require protective clothing.

##### 1.2.6.1 Standard Intruder Movement

Standard intruder movement is defined as any movement such as walking, running, crawling, rolling, or jumping through a protected zone in the most advantageous manner for the intruder.

#### 1.2.7 False Alarm Rate

##### 1.2.7.1 Interior

A false alarm rate of no more than 1 false alarm per sensor per 30 days at the specified probability of detection shall be provided.

##### 1.2.7.2 Exterior

A false alarm rate of no more than 1 false alarm per sensor per 5 days at the specified probability of detection shall be provided.

#### 1.2.8 Error and Throughput Rates

Error and throughput rates shall be single portal performance rates obtained when processing individuals 1 at a time.

##### 1.2.8.1 Type I Error Rate

Type I error rate is defined as an error where the system denies entry to an authorized, enrolled individual. The rate shall be less than 1 percent.

##### 1.2.8.2 Type II Error Rate

Type II error rate is defined as an error where the system grants entry to an unauthorized individual. The entry control Type II error rate shall be less than 0.1 percent.

#### 1.2.9 System Throughput

At the specified error rates, the system throughput rate through a single portal shall be as shown.

#### 1.2.10 Passage

Passage is defined as ingress and/or egress past an entry control device, or through a portal. Entry control procedures and equipment shall be

implemented for passage through each portal as shown.

#### 1.2.11 Detection Resolution

The system shall have detection resolution sufficient to locate intrusions at each device and zone; and tampering at individual devices.

#### 1.2.12 Electrical Requirements

Electrically powered Card Access System equipment shall operate on 120 volt 60 Hz ac sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

#### 1.2.13 System Reaction

##### 1.2.13.1 System Response

The field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the central station within 1 second of the alarm occurring at a local processor or device controlled by a local processor, and within 100 milliseconds if the alarm occurs at the central station. Alarm and status changes shall be displayed within 100 milliseconds after receipt of data by the central station. All graphics shall be displayed, including graphics generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

#### 1.2.14 Environmental Conditions

##### 1.2.14.1 Interior, Controlled Environment

System components, except the console equipment installed in interior locations, having controlled environments shall be rated for continuous operation under ambient environmental conditions of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.

##### 1.2.14.2 Interior, Uncontrolled Environment

System components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 0 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.

##### 1.2.14.3 Console

Console equipment, unless designated otherwise, shall be rated for continuous operation under ambient environmental conditions of 60 to 85 degrees F and a relative humidity of 20 to 80 percent.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL

## PROCEDURES:

## SD-02 Shop Drawings

System Drawings; G, RE

## SD-03 Product Data

Manufacturer's Data; G, RE  
System Description and Analyses; G, RE  
Software Data; G, RE  
Graphics; G, RE

## SD-06 Test Reports

Test Reports; G, RE

## SD-07 Certificates

Certifications; G, RE

## SD-08 Manufacturer's Instructions

Training Documentation; G, RE

## SD-10 Operation and Maintenance Data

Data Entry; G, RE  
Manuals; G, RE  
Functional Design Manual; G, RE  
Hardware Manual; G, RE  
Software Manual; G, RE  
Operator's Manual; G, RE  
Maintenance Manual; G, RE

## SD-11 Closeout Submittals

Final System Drawings; G, RE

## 1.4 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

All items of computer software and technical data (including technical data which relates to computer software), which is specifically identified in this specification shall be delivered to the Government. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. All data packages shall be approved by the Defense Intelligence Agency (DIA) before installation.

## 1.4.1 Group I Technical Data Package

## 1.4.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. Console installation, block diagrams, and wiring diagrams.
- c. Local processor installation, typical block, and wiring diagrams.

- d. Local processor physical layout and schematics.
- e. Device wiring and installation drawings.
- f. Details of connections to power sources, including power supplies and grounding.
- g. Sensor detection patterns.

#### 1.4.1.2 Manufacturer's Data

The data package shall include manufacturer's data for all materials and equipment, including terminal devices, local processors and central station equipment provided under this specification.

#### 1.4.1.3 System Description and Analyses

The data package shall include system descriptions, analyses, and calculations used in sizing equipment specified. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Central processor memory size.
- b. Communication speeds and protocol descriptions.
- c. Hard disk size and configuration.
- d. Floppy disk size and configuration.
- e. Alarm response time calculations.
- f. Command response time calculations.
- g. Start-up operations.
- h. Sample copy of each report specified.
- i. Color photographs representative of typical graphics.

#### 1.4.1.4 Software Data

The software data package shall consist of descriptions of the operation and capability of system, and application software as specified.

#### 1.4.1.5 Certifications

Specified manufacturer's certifications shall be included with the data package certification.

#### 1.4.2 Test Reports

- a. The Contractor shall prepare test procedures and reports for the pre-delivery test.
- b. The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The

Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval.

#### 1.4.3 Training Documentation

Lesson plans and training manuals for the training phases, including type of training to be provided, and a list of reference material, shall be delivered for approval.

#### 1.4.4 Data Entry

The Contractor shall enter all data needed to make the system operational. The Contractor shall deliver the data to the Government on data entry forms, utilizing data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify and request from the Government, any additional data needed to provide a complete and operational Card Access System. The completed forms shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.4.5 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install the graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the Government, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 x 10 inches in size, of each type of graphic to be used for the completed system. The graphics examples shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.3.5 Manuals

Final copies of the manuals as specified, bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representative for each item of equipment. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include modifications made during installation, checkout, and acceptance.

#### 1.4.6 Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

#### 1.4.7 Hardware Manual

A manual describing all equipment furnished including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. System schematics and layout drawings.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.4.8 Software Manual

The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

- a. Definition of terms and functions.
- b. Use of system and applications software.
- c. Procedures for system initialization, start-up and shutdown.
- d. Alarm reports.
- e. Reports generation.
- f. Data base format and data entry requirements.
- g. Directory of all disk files.
- h. Description of all communication protocols, including data formats, command characters, and a sample of each type of data transfer.

#### 1.4.9 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:

- a. Computers and peripherals.
- b. System start-up and shutdown procedures.
- c. Use of system, and applications software.
- d. Recovery and restart procedures.
- e. Graphic alarm presentation.
- f. Use of report generator and generation of reports.

- g. Data entry.
- h. Operator commands.
- i. Alarm and system messages and printing formats.
- j. System entry requirements.

#### 1.4.10 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.4.11 Final System Drawings

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the system to be used for final system drawings. This set shall be accurately kept up-to-date by the Contractor with all changes and additions to the Card Access System and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Final drawings submitted with the endurance test report shall be finished drawings on vellum and CD-ROM.

### 1.5 TESTING

#### 1.5.1 General

The Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed Card Access System. The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test; notice shall not be given until after the Contractor has received written approval of the specific test procedures.

#### 1.5.2 Test Procedures and Reports

Test procedures shall explain in detail, step-by-step actions and expected results, demonstrating compliance with the requirements specified. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

### 1.6 TRAINING

#### 1.6.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the system as specified. The training shall be oriented to the specific system being installed. Training manuals shall be delivered for each trainee with 2 additional copies delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audio-visual equipment and other training materials and supplies. Where the Contractor presents portions of the course by audio-visual material, copies of the audio-visual material shall be delivered to the Government either as a part

of the printed training manuals or on the same media as that used during the training sessions. A training day is defined as 8 hours of classroom instruction, including 2 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with Card Access System. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

#### 1.6.2 Operator's Training I

The first course shall be taught at the project site for a period of 2 consecutive training days at least 3 months prior to the scheduled performance verification test. A maximum of 12 personnel shall attend this course. Upon completion of this course, each student, using appropriate documentation, shall be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

- a. General System hardware architecture.
- b. Functional operation of the system.
- c. Operator commands.
- d. Data base entry.
- e. Reports generation.
- f. Alarm reporting.
- g. Diagnostics.

#### 1.6.3 Operator's Training II

The second course shall be taught at the project site for a period of 2 consecutive training days during or after the Contractor's field testing, but before commencing the performance verification test. A maximum of 12 personnel shall attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system. Upon completion of this course, each student shall be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system.

#### 1.6.4 System Manager Training

Four system managers shall be trained for at least 1 day. The system manager training shall consist of the operator's training and the following:

- a. Enrollment/disenrollment.
- b. Assignments of identifier data.
- c. Assign operator password/levels.



- d. Change database configuration.
- e. Modify graphics.
- f. Print special or custom reports.
- g. System backup.
- h. Any other functions necessary to manage the system.

#### 1.6.5 Maintenance Personnel Training

The system maintenance course shall be taught at the project site after completion of the endurance test for a period of 1 training day. A maximum of 5 personnel, designated by the Government, will attend the course. The training shall include:

- a. Physical layout of each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventive maintenance procedures and schedules.
- e. Calibration procedures. Upon completion of this course, the students shall be fully proficient in the maintenance of the system.

#### 1.7 LINE SUPERVISION

##### 1.7.1 Signal and Data Transmission System (DTS) Line Supervision

All signal and DTS lines shall be supervised by the system. The system shall supervise the signal lines by monitoring the circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment. The system shall initiate an alarm in response to a current change of 10 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTS lines.

##### 1.7.2 Data Encryption

The system shall incorporate data encryption equipment on data transmission circuits as shown. The algorithm used for encryption shall be 128-bit (or greater) and be National Institute of Standards (NIST).

#### 1.8 COMPLIANCE

The card access system shall be configured in accordance with UL 2050. The equipment to be furnished shall be compatible and UL listed, Defense Intelligence Agency (DIA) approved or listed.

#### 1.9 QUALIFICATIONS

The installing Contractor shall be UL certified to install and service UL 2050 systems. In addition, the installing Contractor shall have installed at least two security systems in secure compartment information facilities within the past five years.

## 1.10 MAINTENANCE AND SERVICE

### 1.10.1 Warranty Period

The Contractor shall provide services required and equipment necessary to maintain the entire system in an operational state as specified, for a period of 1 year after formal written acceptance of the system, and shall provide necessary material required for performing scheduled adjustments or other nonscheduled work.

### 1.10.2 Description of Work

The adjustment and repair of the system includes all computer equipment, software updates, communications transmission equipment and DTS, local processors, sensors and entry control, facility interface, and support equipment. Responsibility shall be limited to Contractor installed equipment. The manufacturer's required adjustments and other work as necessary shall be provided.

### 1.10.3 Personnel

Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any change in personnel.

### 1.10.4 Schedule of Work

The Contractor shall perform 2 minor inspections at 6 month intervals (or more often if required by the manufacturer), and 2 major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

#### 1.10.4.1 Minor Inspections

Minor inspections shall include visual checks and operational tests of console equipment, peripheral equipment, local processors, sensors, and electrical and mechanical controls. Minor inspections shall also include mechanical adjustments, new ribbons, and other necessary adjustments on printers.

#### 1.10.4.2 Major Inspections

Major inspections shall include work described under paragraph Minor Inspections and the following work:

- a. Clean all system equipment and local processors, including interior and exterior surfaces.
- b. Perform diagnostics on all equipment.
- c. Check, walk test, and calibrate each sensor.
- d. Run all system software diagnostics and correct all diagnosed problems.
- e. Resolve any previous outstanding problems.

f. Purge and compress data bases.

#### 1.10.4.3 Scheduled Work

Scheduled work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

#### 1.10.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within 2 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.

#### 1.10.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable tests of the performance verification test.

#### 1.10.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.

#### 1.10.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

#### 1.10.9 Software

The Contractor shall provide a description of all software updates to the Government, who will then decide whether or not they are appropriate for implementation. After notification by the Government, the Contractor shall implement the designated software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with system operators, and shall be incorporated into the operation and maintenance manuals, and software documentation. There shall be at least 1 scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Contractor's software.

## PART 2 PRODUCTS

### 2.1 MATERIALS REQUIREMENTS

#### 2.1.1 Materials and Equipment

Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place. System equipment shall conform to UL 294 and UL 1076.

#### 2.1.2 Field Enclosures

##### 2.1.2.1 Interior Sensor

Sensors to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.

##### 2.1.2.2 Interior Electronics

System electronics to be used in an interior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 12.

#### 2.1.3 Nameplates

Laminated plastic nameplates shall be provided for local processors. Each nameplate shall identify the local processor and its location within the system. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 x 3 inches, with minimum 1/4 inch high engraved block lettering. Nameplates shall be attached to the inside of the enclosure housing the local processor. Other major components of the system shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a corrosion resistant plate secured to the item of equipment. Nameplates will not be required for devices smaller than 1 x 3 inches.

#### 2.1.4 Tamper Provisions

##### 2.1.4.1 Tamper Switches

Enclosures, cabinets, housings, boxes, and fittings having hinged doors or removable covers and which contain circuits or connections of the system and its power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch shall function together and shall not allow direct line of sight to any internal components before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover; and shall be wired so that they break the circuit when the door or cover is disturbed.

a. Nonsensor Enclosures: Tamper switches on nonsensor enclosures which must be opened to make routine maintenance adjustments to the system

and to service the power supplies shall be push/pull-set, automatic reset type.

b. Sensor Enclosures: Tamper switches on sensor enclosures which must be opened to make routine maintenance adjustments to the sensor shall be provided.

#### 2.1.4.2 Enclosure Covers

Covers of pull and junction boxes provided to facilitate initial installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place or by tamper resistant security fasteners. Labels shall be affixed to such boxes indicating they contain no connections.

#### 2.1.5 Locks and Key-Lock Switches

##### 2.1.5.1 Locks

Locks shall be provided on system enclosures for maintenance purposes. Locks shall be UL listed, round-key type with 3 dual, 1 mushroom, 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be arranged so that the key can only be withdrawn when in the locked position. Maintenance locks shall be keyed alike and only 2 keys shall be furnished for all of these locks. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

##### 2.1.5.2 Key-Lock-Operated Switches

Key-lock-operated switches required to be installed on system components shall be UL listed, round-key type, with 3 dual, 1 mushroom, and 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be 2 position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only 2 keys shall be furnished for each key-lock-operated-switch. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

#### 2.1.6 System Components

System components shall be designed for continuous operation. Electronic components shall be solid state type, mounted on printed circuit boards conforming to UL 796. Printed circuit board connectors shall be plug-in, quick-disconnect type.

##### 2.1.6.1 Modularity

Equipment shall be designed for increase of system capability by installation of modular components. System components shall be designed to facilitate maintenance through replacement of modular subassemblies and parts.

##### 2.1.6.2 Maintainability

Components shall be designed to be maintained using commercially available

tools and equipment. Components shall be arranged and assembled so they are accessible to maintenance personnel. There shall be no degradation in tamper protection, structural integrity, EMI/RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions. The system shall be configured and installed to yield a mean time to repair (MTTR) of not more than 8 hours. Repair time is the clock time from when maintenance personnel gain entrance to the system and begin work, until the system is fully functional.

#### 2.1.6.3 Interchangeability

The system shall be constructed with off-the-shelf components which are physically, electrically and functionally interchangeable with equivalent components as complete items. Replacement of equivalent components shall not require modification of either the new component or of other components with which the replacement items are used. Custom designed or one-of-a-kind items shall not be used.

#### 2.1.6.4 Product Safety

System components shall conform to applicable rules and requirements of NFPA 70 and UL 294.

#### 2.1.7 Controls and Designations

Controls and designations shall be as specified in NEMA ICS 1.

#### 2.1.8 Special Test Equipment

The Contractor shall provide all special test equipment, special hardware, software, tools, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

### 2.2 CENTRAL STATION HARDWARE (CARD ACCESS SERVER)

The central station computer shall be a standard unmodified digital computer of modular design. The CPU word size shall be 64 bits or larger. The operating speed of the processor shall be at least 3 GHz.

#### 2.2.1 Memory

The computer shall contain at least 256 megabytes of usable installed memory.

#### 2.2.2 Power Supply

The power supply shall have a minimum capacity of 400 Watts.

#### 2.2.3 Real Time Clock (RTC)

A RTC shall be provided. Accuracy shall be within plus or minus 1 minute per month. The RTC shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month and shall be resettable by software. The clock shall continue to function for a period of 1 year without power.

#### 2.2.4 Serial Ports

- a. Two EIA ANSI/EIA/TIA-232-F serial ports shall be provided for general use.
- b. Adjustable data transmission rates from 9600 to 57.6 Kbps shall be selectable under program control.
- c. Four USB 2.0 ports.

#### 2.2.5 Parallel Port

An enhanced parallel port shall be provided.

#### 2.2.6 Color Monitor

The monitor shall be no less than 15 inches, flat panel, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. The video card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

#### 2.2.7 Keyboard A101

A keyboard having a minimum 64 character, standard ASCII character, based on ANSI INCITS 154 shall be furnished.

#### 2.2.8 Enhancement Hardware

Enhancement hardware such as special function keyboards, special function keys, touch screen devices, or mouse shall be provided for frequently used operator commands such as: Help, Alarm Acknowledge, Place Zone In Access, Place Zone In Secure, System Test, Print Reports, Change Operator, Security Lighting Controls, and Display Graphics.

#### 2.2.9 Disk Storage

A hard disk with controller having a maximum average access time of 10 milliseconds shall be provided. The hard disk shall provide a minimum of 100 gigabytes of formatted storage. Additionally, a hard disk slot with a removable 100 gigabyte hard drive shall be provided.

#### 2.2.10 Floppy Disk Drives

A high density floppy disk drive and controller in 3-1/2 inch size shall be provided.

#### 2.2.11 Modem

A modem shall be provided and operate at 56.6K bps, full duplex on circuits using asynchronous communications.

#### 2.2.12 Audible Alarm

The manufacturer's standard audible alarm shall be provided.

#### 2.2.13 Mouse

An optical mouse with a minimum resolution of 400 dots per inch shall be provided.

#### 2.2.14 CD-ROM Drive

A CD-ROM drive having a nominal storage capacity of 650 megabytes shall be provided.

#### 2.2.15 Alarm Printer

A dot matrix alarm printer shall be provided and interconnected to the central station equipment. The dot matrix alarm printer shall have a minimum 96 character, standard ASCII character set, based on ANSI INCITS 154 and with graphics capability. The printer shall be able to print in both red and black without ribbon change. The printers shall have adjustable sprockets for paper width up to 11 inches, print at least 80 columns per line and have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per inch. The printers shall utilize sprocket-fed fan fold paper. The units shall have programmable control of top-of-form. Twenty-five thousand sheets of printer paper and 12 ribbons shall be provided after successful completion of the testing.

#### 2.2.16 Controllers

Controllers required for operation of specified peripherals, serial, and parallel ports shall be provided.

#### 2.2.17 Uninterruptible Power Supply (UPS)

A self contained UPS, suitable for installation and operation at the central station, shall be provided. The UPS shall be sized to provide a minimum of 15 minutes of operation of the central station equipment. Equipment connected to the UPS shall not be affected by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.

### 2.3 CENTRAL STATION SOFTWARE

Software shall support all specified functions. The central station shall be online at all times and shall perform required functions as specified. Software shall be resident at the central station and/or the local processor as required to perform specified functions.

#### 2.3.1 System Software

System software shall perform the following functions:

- a. Support multiuser operation with multiple tasks for each user.
- b. Support operation and management of peripheral devices.
- c. Provide file management functions for disk I/O, including creation and deletion of files, copying files, a directory of all files including size and location of each sequential and random ordered record.
- d. Provide printer spooling.



### 2.3.2 Real Time Clock Synchronization

The system shall synchronize each real time clock within 1 second and at least once per day automatically, without operator intervention and without requiring system shutdown.

### 2.3.3 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all parameters and constraints associated with each sensor, commandable output, zone, facility interface device, terminal device, etc. Each database item shall be callable for display or printing, including EPROM, ROM and RAM resident data. The database shall be defined and entered into the Card Access System by the Contractor based upon input from the Government.

### 2.3.4 Software Tamper

The Card Access System shall annunciate a tamper alarm when unauthorized changes to the system database files are attempted. Three consecutive unsuccessful attempts to log onto the system shall generate a software tamper alarm. A software tamper alarm shall also be generated when an operator or other individual makes 3 consecutive unsuccessful attempts to invoke central processor functions beyond their authorization level. The Card Access System shall maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. The system shall not allow write access to the system transcript files by any person, regardless of their authorization level. The system shall only allow acknowledgment of software tamper alarms and read access to the system transcript files by operators and managers with the highest password authorization level available in the system.

### 2.3.5 Application Software

The application software shall provide the interface between the alarm annunciation and entry control local processors; monitor all sensors and DTS links; operate displays; report alarms; generate reports; and assist in training system operators.

#### 2.3.5.1 Operator Commands

The operator's commands shall provide the means for entry of monitoring and control commands, and for retrieval of system information. Processing of operator commands shall commence within 1 second of entry, with some form of acknowledgment provided at that time. The operator's commands shall perform tasks including:

- a. Request help with the system operation.
- b. Acknowledge alarms.
- c. Place zone in access.
- d. Place zone in secure.
- e. Test the system.
- f. Generate and format reports.

- g. Print reports.
- h. Change operator.
- i. Control security lighting.
- j. Request any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
- k. Entry control functions.

#### 2.3.5.2 Command Input

Operator's commands shall be full English language words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator in English word, phrase, or acronym. Commands shall be available in an abbreviated mode, in addition to the full English language (words and acronyms) commands, allowing an experienced operator to disregard portions, or all, of the prompt-response requirements.

#### 2.3.5.3 Command Input Errors

The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator, in English words and phrases, why the command cannot be executed. Error responses requiring an operator to look up a code in a manual or other document will not be accepted. Conditions for which operator error assist messages shall be generated include:

- a. The command used is incorrect or incomplete.
- b. The operator is restricted from using that command.
- c. The command addresses a point which is disabled or out of service.
- d. The command addresses a point which does not exist.
- e. The command would violate constraints.

#### 2.3.5.4 Enhancements

The system shall implement the following enhancements by use of special function keys, touch screen, or mouse, in addition to all other command inputs specified:

- a. Help: Used to produce a display for all commands available to the operator. The help command, followed by a specific command shall produce a short explanation of the purpose, use, and system reaction to that command.
- b. Acknowledge Alarms: Used to acknowledge that the alarm message has been observed by the operator.
- c. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. The system shall be structured so that tamper circuits cannot be disabled by the console operator.

d. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.

e. System Test: Allows the operator to initiate a system wide operational test.

f. Zone Test: Allows the operator to initiate an operational test for a specific zone.

g. Print Reports: Allows the operator to initiate printing of reports.

h. Change Operator: Used for changing operators.

i. Security Lighting Controls: Allows the operator to remotely turn on/off security lights.

j. Display Graphics: Used to display any graphic displays implemented in the system.

#### 2.3.5.5 System Access Control

The system shall provide a means to define system operator capability and functions through multiple, password protected operator levels. At least 3 operator levels shall be provided. System operators and managers with appropriate password clearances shall be able to change operator levels for all operators. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm. A minimum of 32 passwords shall be usable with the system software. The system shall display the operator's name or initials in the console's first field. The system shall print the operator's name or initials, action, date, and time on the system printer at log-on and log-off. The password shall not be displayed or printed. Each password shall be definable and assignable for the following:

- a. Commands usable.
- b. Access to system software.
- c. Access to application software.
- d. Individual zones which are to be accessed.
- e. Access to database.

#### 2.3.5.6 Alarm Monitoring Software

This program shall monitor all sensors, local processors and DTS circuits and notify the operator of an alarm condition. Alarms shall be printed in red on the alarm printer and displayed on the console's text monitors. Higher priority alarms shall be displayed first; and within alarm priorities, the oldest unacknowledged alarm shall be displayed first. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Alarm data to be displayed shall include type of alarm, location of alarm, and secondary alarm messages. Alarm data to be printed shall include: type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator response. A unique message field with a width of 60 characters shall be provided for each alarm. Assignment of

messages to a zone or sensor shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator. The system shall provide for 25 secondary messages with a field of 4 lines of 60 characters each. The most recent 1000 alarms shall be stored and shall be recallable by the operator using the report generator.

#### 2.3.5.7 Monitor Display Software

Monitor display software shall provide for text displays that include zone status integrated into the display. Different colors shall be used for the various components and real time data. Colors shall be uniform on all displays. The following color coding shall be followed.

- a. FLASHING RED to alert an operator that a zone has gone into an alarm or that primary power has failed.
- b. RED to alert an operator that a zone is in alarm and that the alarm has been acknowledged.
- c. YELLOW to advise an operator that a zone is in access.
- d. GREEN to indicate that a zone is secure or that power is on.

#### 2.3.5.8 Map Displays/Graphics Linked to Alarms

The System shall relate map displays or other graphics to alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the map display or graphic related to the alarm shall be automatically displayed. The definition of which maps or graphics shall be displayed with each alarm shall be selectable by system operators through simple menu choices as part of the system initial configuration.

#### 2.3.5.9 User Defined Prompts/Messages Linked to Alarms

The System shall provide a means to relate operator defined prompts and other messages to predefined alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the prompts or messages related to the alarm shall be automatically displayed.

#### 2.3.5.10 System Test Software

This software shall enable the operator to initiate a test of the system. This test can be of the entire system or of a particular portion of the system at the operator's option. The results of each test shall be stored for future display or print out in report form.

#### 2.3.5.11 Report Generator

Software shall be provided with commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time and shall be printed on the report printer. Reports shall be spooled, allowing the printing of one report to be complete before the printing of another report commences. The dynamic operation of the system shall not be interrupted to generate a report. The report generation mode, either periodic, automatic or on request, shall be operator selectable. The report shall contain the time and date when the report was printed, and the name of operator generating the report. The exact format of each report type shall be operator configurable.

a. Periodic Automatic Report Modes: The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

b. Request Report Mode: The system shall allow the operator to request at any time an immediate printout of any report.

c. Alarm Report: The alarm report shall include all alarms recorded by the system over an operator selectable time. The report shall include such information as: the type of alarm (intrusion, tamper, etc.); the type of sensor; the location; the time; and the action taken.

d. System Test Report: This report documents the operational status of all system components following a system test.

e. Access/Secure Report: This report documents all zones placed in access, the time placed in access, and the time placed in secure mode.

f. Entry Control Reports: The system shall generate hard copy reports of identifier, terminal, and guard tour tracking reports, and versions with defined parameters of the manufacturer's standard management and activity reports.

#### 2.3.5.12 Simulation (Training) Software

This program shall enable operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. The system shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

#### 2.3.5.13 Entry Control Enrollment Software

The enrollment station shall provide database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed. The enrollment station shall not have any alarm response or acknowledgment functions. Multiple, password protected access levels shall be provided at the enrollment station. Database management and modification functions shall require a higher operator access level than personnel enrollment functions. The program shall provide a means for disabling the enrollment station when it is unattended to prevent unauthorized use. The program shall provide a method to enter personnel identifying information into the entry control database files through enrollment stations. In the case of personnel identity verification subsystems, this data shall include biometric data. The program shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs. All personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry control database files.

### 2.4 FIELD PROCESSING HARDWARE

#### 2.4.1 Entry Control Local Processor (Card Reader Access Controller)

The entry control local processor shall respond to interrogations from the

field device network, recognize and store alarm status inputs until they are transmitted to the central station and change outputs based on commands received from the central station. The local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs. The entry control local processor shall provide local entry control functions including communicating with field devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators and exit pushbuttons. The processor shall also accept data from entry control field devices as well as database downloads and updates from the central station that include enrollment and privilege information. The processor shall also send indications of success or failure of attempts to use entry control field devices and make comparisons of presented information with stored identification information. The processor shall grant or deny entry by sending control signals to portal control devices and mask intrusion alarm annunciation from sensors stimulated by authorized entries. The entry control local processor shall use inputs from entry control devices to change modes between access and secure. The local processor shall maintain a date-time and location stamped record of each transaction and transmit transaction records to the central station. The processor shall operate as a stand-alone portal controller using the downloaded data base during periods of communication loss between the local processor and the field device network. The processor shall store up to 1000 transactions during periods of communication loss between the local processor and the field device network for subsequent upload to the central station upon restoration of communication. The local processor shall provide power for field devices and portal control devices.

- a. Inputs. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions. The local processor shall have at least 8 alarm inputs which allow wiring as normally open or normally closed contacts for alarm conditions. It shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements. The local processor shall report line supervision alarms to the central station. Alarms shall be reported for any condition that remains off normal at an input for longer than 500 milliseconds. Each alarm condition shall be transmitted to the central station during the next interrogation cycle. The entry control local processor shall include the necessary software drivers to communicate with entry control field devices. Information generated by the entry control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges. Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time and location stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
- b. Outputs. Local processor outputs shall reflect the state of commands issued by the central station. The outputs shall be a

form C contact and shall include normally open and normally closed contacts. The local processor shall have at least 4 commandable outputs. The entry control local processor shall also provide control outputs to portal control devices.

- c. Degraded Mode of Operation. The entry control local processor shall provide a degraded mode of operation for periods when communication between the local processor and the field device network is lost. While in this degraded mode, the local processor shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal control devices. Transactions shall be stored for subsequent transmission to the central station when communication is restored.

#### 2.4.1.1 Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 4 hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa. All card readers, magnetic locks, etc., shall be fully functional when local processor is on battery. Batteries shall be sealed, non-outgassing type. The power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.

### 2.5 FIELD PROCESSING SOFTWARE

All Field processing software described in this specification shall be furnished as part of the complete system.

#### 2.5.1 Operating System

Each local processor shall contain an operating system that controls and schedules that local processor's activities in real time. The local processor shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that local processor. The execution of local processor application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each local processor real time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds. The time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown.

##### 2.5.1.1 Startup

The local processor shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected Input/Output functions. A local processor restart program based on detection of power failure at the local processor shall be included in the local processor software. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the

database and application programs are resident, the local processor shall immediately resume operation.

#### 2.5.1.2 Operating Mode

Each local processor shall control and monitor inputs and outputs as specified, independent of communications with the central station. Alarms, status changes and other data shall be transmitted to the central station when communications circuits are operable. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station shall be stored for later transmission to the central station. Storage for the latest 1024 events shall be provided at each local processor. Each local processor shall accept software downloaded from the central station.

#### 2.5.1.3 Failure Mode

Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

#### 2.5.2 Functions

The Contractor shall provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each local processor.

- a. Monitoring of inputs.
- b. Control of outputs.
- c. Reporting of alarms automatically to the central station.
- d. Reporting of sensor and output status to central station upon request.
- e. Maintenance of real time, automatically updated by the central station at least once a day.
- f. Communication with the central station.
- g. Execution of local processor resident programs.
- h. Diagnostics.
- i. Download and upload data to and from the central station.

#### 2.6 INTERIOR SENSORS AND CONTROL DEVICES

##### 2.6.1 Balanced Magnetic Switch (BMS)

The BMS shall detect a 1/4 inch of separating relative movement between the magnet and the switch housing. Upon detecting such movement, the BMS shall transmit an alarm signal to the alarm annunciation system.



#### 2.6.1.1 BMS Subassemblies

The BMS shall consist of a switch assembly and an actuating magnet assembly. The switch mechanism shall be of the balanced magnetic type. Each switch shall be provided with an overcurrent protective device, rated to limit current to 80 percent of the switch capacity. Switches shall be rated for a minimum lifetime of 1,000,000 operations. The magnet assembly shall house the actuating magnet.

#### 2.6.1.2 Housing

The housings of surface mounted switches and magnets shall be made of nonferrous metal and shall be weatherproof. The housings of recess mounted switches and magnets shall be made of nonferrous metal or plastic.

#### 2.6.2 Duress Alarm Switches

Duress alarm switches shall provide the means for an individual to covertly notify the alarm annunciation system that a duress situation exists.

##### 2.6.2.1 Push-button

Latching push-button duress alarm switches shall be designed to be activated by depressing a push-button located on the duress switch housing. No visible or audible alarm or noise shall emanate from the switch. The switch housing shall shroud the activating button to prevent accidental activation. Switches shall be rated for a minimum lifetime of 50,000 operations.

#### 2.6.3 Passive Infrared Motion Sensor

The passive infrared motion sensor shall detect changes in the ambient level of infrared emissions caused by the movement of a standard intruder within the sensor's field of view. Upon detecting such changes, the sensor shall transmit an alarm signal to the alarm annunciation system. The sensor shall detect a change in temperature of no more than 2.5 degrees F, and shall detect a standard intruder traveling within the sensor's detection pattern at a speed of 0.3 to 7.5 feet per second across 2 adjacent segments of the field of view. Emissions monitored by the sensor shall be in the 8 to 14 micron range. The sensor shall be adjustable to obtain coverage patterns. The sensor shall be equipped with a temperature compensation circuit. Suggested manufacturer and model number for the passive infrared motion sensor is Pulnix PA 7100 series.

##### 2.6.3.1 Test Indicator, Passive Infrared

The passive infrared motion sensor shall be equipped with an LED walk test indicator. The walk test indicator shall not be visible during normal operations. When visible, the walk test indicator shall light when the sensor detects an intruder. The sensor shall either be equipped with a manual control, located within the sensor's housing, to enable/disable the test indicator or the test indicator shall be located within the sensor housing so that it can only be seen when the housing is open or removed.

#### 2.7 ENTRY CONTROL DEVICES

##### 2.7.1 Card Readers and Credential Cards

Entry control card readers shall use unique coded data stored in or on a

compatible credential card as an identifier. The card readers shall be proximity type, and shall incorporate built-in heaters or other cold weather equipment to extend the operating temperature range as needed for operation at the site. Communications protocol shall be compatible with the local processor. The Contractor shall furnish card readers to read internal identification chip entry cards, and the matching credential cards. The cards shall contain coded data arranged as a unique identification code stored on or within the card, and of the type readable by the card readers. The Contractor shall include within the card's encoded data, a non-duplicated unique facility identification code common to all credential cards provided at the site. Enrollment equipment to support local encoding of badges including cryptographic and other internal security checks shall be supplied.

#### 2.7.1.1 Proximity

Proximity card readers shall use passive proximity detection and shall not require contact with the proximity credential card for proper operation. Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number. The card reader shall read proximity cards in a range from 0 inches to at least 6 inches from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.

#### 2.7.1.2 Card Reader Display

The card readers shall include an LED or other visual indicator display. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

#### 2.7.1.3 Card Reader Response Time

The card reader shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less, from the time the card reader finishes reading the credential card until a response signal is generated.

#### 2.7.1.4 Card Reader Mounting Method

Card readers shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

#### 2.7.1.5 Credential Card

Entry control cards shall be able to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge as need for the site without reduction of readability.

The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type badge holder used at the site.

#### 2.7.1.6 Card Size and Dimensional Stability

Credential cards shall be 2-1/8 x 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

#### 2.7.1.7 Card Materials and Physical Characteristics

The credential card shall be abrasion resistant, non-flammable, and present no toxic hazard to humans when used in accordance with manufacturer's instructions. The credential card shall be impervious to solar radiation and the effects of ultra-violet light.

#### 2.7.1.8 Card Construction

The credential card shall be of core and laminate or monolithic construction. Lettering, logos and other markings shall be hot stamped into the credential material or direct printed. The Contractor shall provide a means to allow onsite assembly and lamination of credential cards by Government personnel. Provide all necessary printers, laminator, etc., for onsite assembly of cards.

#### 2.7.1.9 Card Durability and Maintainability

The credential cards shall be designed and constructed to yield a useful lifetime of at least 5000 insertions or swipes or 5 years, whichever results in a longer period of time. The credential card shall be able to be cleaned by wiping the credential card with a sponge or cloth wet with a soap and water solution. Furnish 200 credential cards to Government at project completion.

#### 2.7.2 Keypads

Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. Communications protocol shall be compatible with the local processor.

##### 2.7.2.1 Keypad Display

Keypads shall include an LED or other type of visual indicator display and provide visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

##### 2.7.2.2 Keypad Response Time

The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.

##### 2.7.2.3 Keypad Power

The keypad shall be powered from the local processor.

#### 2.7.2.4 Keypad Mounting Method

Keypads shall be suitable for semi-flush mounting as shown.

#### 2.7.2.5 Keypad Duress Codes

Keypads shall provide a means for users to indicate a duress situation by entering a special code.

#### 2.7.2.6 Hand Geometry

Hand geometry devices shall use unique human hand measurements to identify authorized, enrolled personnel. The design of this device shall incorporate positive measures to establish that the hand being measured by the device belongs to a living human being. Hand geometry devices shall provide an alignment system which allows the user's hand to remain in full view of the user at all times. During the scan process the hand geometry device shall make 3 dimensional measurements of the size and shape of the user's hand. The hand geometry device shall automatically initiate the scan process once the user's hand is properly positioned by the alignment system. The hand geometry device shall be able to use either left or right hands for enrollment and verification. Hand geometry devices shall include an LED or other type of visual indicator display and provide visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

a. Template Update and Acceptance Tolerances: Hand geometry devices shall not automatically update a user's profile. Significant changes in an individual's hand geometry shall require re-enrollment. The hand geometry devices shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control. The hand geometry device shall determine when multiple attempts are needed for hand geometry verification, and shall automatically prompt the user for additional attempts up to a maximum of 3. Three failed attempts shall generate an entry control alarm.

b. Average Verification Time: The hand geometry device shall respond to passage requests by generating signals to the local processor. The verification time shall be 1.5 seconds or less from the moment the hand geometry device initiates the scan process until the hand geometry device generates a response signal.

c. Modes: The hand geometry device shall provide an enrollment mode, recognition mode, and code/credential verification mode. The enrollment mode shall create a hand template for new personnel and enter the template into the entry control database file created for that person. Template information shall be compatible with the system application software. The operating mode shall be selectable by the system manager/operator from the central processor. When operating in recognition mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches a hand geometry template stored in the database files. When operating in code/credential verification mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches the hand geometry template associated with the identification code entered into a keypad.

d. Reports: The hand geometry device shall create and store template match scores for all transactions involving hand geometry scans. The

template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, and shall be used for report generation.

e. Electrical: Hand geometry device shall be powered from the card access system power supply.

f. Mounting Method: Hand geometry devices shall be suitable for surface, flush, or pedestal mounting as required.

g. Communications Protocol: The communications protocol between the hand geometry device and the local processor shall be compatible.

### 2.7.3 Portal Control Devices

#### 2.7.3.1 Push-button Switches (Exit Button)

Provide momentary contact, back lighted push buttons and stainless steel switch enclosures for each push button as shown. Switch enclosures shall be suitable for flush mounting. Push button switch labeled with 1/4 inch high text and symbols as required. The push button switches shall be connected to the inputs of the local processor associated with the portal to which they are applied and shall operate the appropriate electric strike, electric bolt or other facility release device. Switches shall have a minimum continuous current rating of 10 Amperes at 120 Vac or 5 Amperes at 240 Vac.

#### 2.7.3.2 Remote Door Release Buttons

Provide momentary contact, back lighted push buttons and stainless steel switch enclosures. Switch enclosures shall be suitable for desk mounting. Multiple push buttons are housed within a single switch enclosure and shall be stacked vertically with each push button switch labeled with 1/4 inch high text and symbols as required. The push button switches shall be connected to the local processor associated with the portal to which they are applied and shall operate the appropriate electric strike, electric bolt or other facility release device. Switches shall have a minimum continuous current rating of 1 Amperes at 120 Vac. Provide 1/4 inch stainless steel cable from push button enclosure to wall box.

#### 2.7.3.3 Panic Bar Exit

Panic bar exit hardware is specified under the door hardware trade. coordinate connection to panic bar switch with door hardware trade.

#### 2.7.3.4 Electromagnetic Lock (Electromagnetic Door Release)

Electromagnetic locks shall contain no moving parts and shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall release automatically in case of power failure and shall require manual reset to resume normal function. The lock shall interface with the local processors without external, internal or functional alteration of the local processor. The electromagnetic lock shall incorporate an end of line resistor to facilitate line supervision by the system.

a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 12 or 24 Volts dc and shall not

dissipate more than 12 Watts. The holding current shall be not greater than 500 milliamperes. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.

c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware as shown, and shall be compatible with right or left hand mounting.

#### 2.7.3.5 Door Strike

Door strike is specified under the door hardware trade. Coordinate connection, voltage, and current requirements for door strike with door hardware trade.

#### 2.7.3.6 Electromagnetic Lock With Delay Egress (Electromagnetic Door Release)

Electromagnetic locks shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall release automatically in case of power failure and shall require manual reset to resume normal function. The lock shall have an integral displacement sensor that when the door is pushed, initiates a non-reversible release of door within an adjustable 15 to 30 second delay period. The lock shall interface with the local processors without external, internal or functional alteration of the local processor.

The electromagnetic lock shall incorporate an end of line resistor to facilitate line supervision by the system.

a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 12 or 24 Volts dc. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.

c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware as shown, and shall be compatible with right or left hand mounting.

### 2.8 ENTRY CONTROL SOFTWARE

#### 2.8.1 Interface Device

The entry control software shall control passage. The decision to grant or deny passage shall be based upon identifier data to be input at a specific location. If all conditions are met, a signal shall be sent to the input device location to activate the appropriate electric strike, bolt, electromagnetic lock or other type of portal release or facility interface device.

#### 2.8.2 Operator Interface

Entry control operation shall be entirely automatic under control of the

central station and local processors except for simple operations required for map display, alarm acknowledgment, zone and portal status change operations, audible or visual alarm silencing and audio annunciation. The system shall immediately annunciate changes in zone and portal status. The alarm printer shall print a permanent record of each alarm and status change. The map displays or graphics screens shall display the current status of system zones and portals. The central station shall immediately display the current status of any zone or portal upon command. While the system is annunciating an unacknowledged zone or portal alarm, keyboard operations at the central station, other than alarm acknowledgment, shall not be possible. The system shall provide the capability to change zone and portal status from alarm (after alarm acknowledgment) or access to secure; from alarm (after alarm acknowledgment) or secure to access, or from access to secure by simple control operations. If the operator attempts to change zone status to secure while there is an alarm output for that zone or portal, the system shall immediately annunciate an alarm for that zone or portal.

### 2.8.3 Entry Control Functions

#### 2.8.3.1 Multiple Security Levels

The system shall have multiple security levels. Each of the security levels shall be delineated by facility barriers. Access to each security level shall be through portals in the facility barriers using designated entry control procedures. The system shall provide at least 8 security levels. Any attempt to access an area beyond an individual's security level shall initiate an access denial alarm.

#### 2.8.3.2 Two Person Rule

The system shall provide a 2 person rule feature. When a portal is designated as a 2 person rule portal, it shall not allow passage unless 2 valid identifiers are presented in the proper sequence. The scheme shall be designed so that only the first 2 valid identifiers and the last 2 valid identifiers pass together.

#### 2.8.3.3 Anti-Passback

Portals as shown shall incorporate anti-passback functions. Anti-passback functions and identifier tracking shall be system-wide for portals incorporating anti-passback. Once an authorized, enrolled individual has passed through a portal using entry control procedures, the system shall not allow use of the same identifier to pass through any portal at the same security level until the individual has egressed through a portal at this same security level using entry control procedures. Any attempt to violate anti-passback procedures shall initiate an access denial alarm. Portals that do not incorporate anti-passback functions shall allow egress from the area by a push-button switch for activation of the facility interface device. Portal egress switch shall be located as shown.

#### 2.8.3.4 Immediate Access Change

The system shall provide functions to disenroll and deny access to any identifier or combination of identifiers without consent of the individual or recovery of a credential. The design of the system shall provide entry change capability to system operators and managers with appropriate passwords at the system operator or enrollment consoles.

#### 2.8.3.5 Multiple Time Zones

The system shall provide multiple time zone entry control. Personnel enrolled in the system shall only be allowed access to a facility during the time of day they are authorized to access the facility. Time zone access control shall also include the ability to specify beginning and ending dates that an individual will be authorized to access a facility. The system shall provide automatic activation and deactivation of entry authorization. The design of the system shall provide at least 16 time zones with overlapping time zones. The system shall provide a means for system operators with proper password clearance, to define custom names for each time zone, and to change the time zone's beginning and ending times through the system operator and enrollment interfaces. The system shall automatically disenroll individuals at the end of their predefined facility access duration. Any attempt during a 24 hour period by an individual or an identifier to gain facility entry outside of the authorized time zone shall initiate an entry denial alarm.

#### 2.8.4 Electronic Entry Control System Capacities

The system shall be designed and configured to provide the following capacities.

##### 2.8.4.1 Enrollees

The system shall be configured for 1000 enrollees. The system shall provide a facility-tailorable reference file database containing personal, access authorization, identifier and verification data for each enrollee as required.

##### 2.8.4.2 Transaction History File Size

The system capacity shall be at least the amount of transactions for the system during 1 year without any loss of transaction data.

#### 2.8.5 Entry Control System Alarms

The system shall annunciate an alarm when the following conditions occur. Alarms shall be annunciated at the console both audibly and visually. An alarm report shall also be printed on the system printer. The alarm annunciation shall continue until acknowledged by the system operator. Only 1 control key shall be needed to acknowledge an alarm. The system shall control, monitor, differentiate, rank, annunciate, and allow operators to acknowledge, in real time, alarm signals generated by system equipment. The system shall also provide a means to define and customize the annunciation of each alarm type. The system shall use audio and visual information to differentiate the various types of alarms. Each alarm type shall be assigned an audio and a unique visual identifier.

##### 2.8.5.1 Duress

The system shall annunciate a duress alarm when a duress code is entered at a keypad or a duress switch is activated. Duress alarms shall be annunciated in a manner that distinguishes them from all other system alarms. Duress alarms shall not be annunciated or otherwise indicated locally nor shall a duress alarm cause any special or unusual indications at the portal or area initiating the duress alarm. Individual privileges shall be carried out the same as an authorized entry to the protected area.

Duress alarms shall only be annunciated at the central station and remote



displays. Alarms shall be annunciated on the monitor and shall be logged on the printer.

#### 2.8.5.2 Entry Denial

The system shall annunciate an alarm when an attempt has been made to pass through a controlled portal and entry has been denied.

#### 2.8.5.3 Portal Open

The system shall annunciate an alarm when an entry controlled portal has been open longer than a predefined time delay. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.8.5.4 Lock/Strike Not Secured

The system shall annunciate an alarm when the lock/strike at an entry controlled portal has been left unsecured longer than a predefined time delay and generate an entry control alarm. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.8.5.5 Alarm Shunting/System Bypass

The system shall provide a means to ignore operator selected alarm types at operator selected portals in order to allow standard entry control procedures to be bypassed (shunted). Predefined alarm shunting shall only be available to system operators with the proper password. The system shall also provide for predefined alarm shunting based upon time zones. This capability shall only apply to the entry control alarm type.

### 2.9 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government furnished equipment. Wiring shall meet NFPA 70 standards.

#### 2.9.1 Above Ground Sensor Wiring

Sensor wiring shall be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Multiconductor wire shall have an outer jacket of PVC.

#### 2.9.2 Local Area Network (LAN) Cabling

LAN cabling shall be in accordance with EIA ANSI/TIA/EIA-568-A, category 6.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

The Contractor shall install all system components, including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown. The contractor shall furnish necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

### 3.1.1 Installation

The contractor shall install the system in accordance with the standards for safety, NFPA 70, UL 681, UL 1037 and UL 1076, and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate service points to pinpoint system trouble in less than 20 minutes. Minimum size of conduit shall be 1/2 inch. DTS shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. Flexible cords or cord connections shall not be used to supply power to any components of the system, except where specifically noted. All other electrical work shall be as specified in Section 16415A, ELECTRICAL WORK, INTERIOR and as shown.

### 3.1.2 Enclosure Penetrations

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in a manner that does not damage the cable.

### 3.1.3 Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc., shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

### 3.1.4 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report any changes in the site, or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

### 3.1.5 Installation Software

The Contractor shall load software as specified and required for an operational system, including data bases and specified programs. Upon successful completion of the endurance test, the Contractor shall provide original and backup copies on CD-ROM of all accepted software, including diagnostics.

## 3.2 SYSTEM STARTUP

Satisfaction of the requirements below does not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment. The Contractor shall not apply power to the system until after:

a. System equipment items and DTS have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.

c. System wiring has been tested and verified as correctly connected.

d. System grounding and transient protection systems have been verified as properly installed.

e. Power supplies to be connected to the system have been verified as the correct voltage, phasing, and frequency.

### 3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed system; and are approved by the Contracting Officer. These representatives shall be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet the contractual requirements.

### 3.4 TESTING

#### 3.4.1 General Requirements for Testing

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during predelivery, performance verification and endurance testing, shall be turned over to the Government at the conclusion of each phase of testing, prior to Government approval of the test.

#### 3.4.2 Test Setup

The predelivery test setup shall include the following:

a. All central station equipment.

b. At least 1 of each type DTS link, but not less than 2 links, and associated equipment to provide a fully integrated system.

c. The number of local processors shall equal the amount required by the site design.

d. At least 1 of each type sensor used.

e. Enough sensor simulators to provide alarm signal inputs to the system equal to the number of sensors required by the design. The alarm signals shall be manually or software generated.

f. At least 1 of each type of terminal device used.

g. At least 1 of each type of portal configuration with all facility

interface devices as specified or shown.

h. Equipment as specified in Section 16751A CLOSED CIRCUIT TELEVISION SYSTEMS when required.

i. The Contractor shall prepare test procedures and reports for the predelivery test, and shall deliver the predelivery test procedures to the Government for approval. The final predelivery test report shall be delivered after completion of the predelivery test.

#### 3.4.3 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTS operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations, including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

#### 3.4.4 Performance Verification Test

The Contractor shall demonstrate that the completed system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

The performance verification test, as specified, shall not be started until after receipt by the Contractor of written permission from the Government, based on the Contractor's written report. The report shall include certification of successful completion of testing as specified in paragraph Contractor's Field Testing, and upon successful completion of training as specified. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

-- End of Section --

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## SECTION 13851A

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## SECTION 13851A

FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE - BATTALION HEADQUARTERS  
**02/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S3.41 (1990; R 1996) Audible Emergency  
Evacuation Signal

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1221 (1999) Installation, Maintenance and Use  
of Public Fire Service Communication  
Systems

NFPA 70 (2002) National Electrical Code

NFPA 72 (2002) National Fire Alarm Code

NFPA 90A (2002) Installation of Air Conditioning  
and Ventilating Systems

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## UNDERWRITERS LABORATORIES (UL)

UL 1242 (1996; Rev Mar 1998) Intermediate Metal  
Conduit

UL 1449 (1996; Rev thru Jul 2002) Transient  
Voltage Surge Suppressors

UL 1971 (1995; Rev thru Apr 1999) Signaling  
Devices for the Hearing Impaired

UL 268 (1996; Rev thru Jan 1999) Smoke Detectors  
for Fire Protective Signaling Systems

UL 268A (1998) Smoke Detectors for Duct Application

UL 38	(1999) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 497B	(1999) Safety Protectors for Data Communication and Fire Alarm Circuits
UL 464	(1996; Rev thru May 1999) Audible Signal Appliances
UL 521	(1999) Heat Detectors for Fire Protective Signaling Systems
UL 6	(1997) Rigid Metal Conduit
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 864	(1996; Rev thru Mar 1999) Control Units for Fire Protective Signaling Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Fire Alarm Reporting System; G, RE

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

### SD-03 Product Data

#### Storage Batteries; G, RE

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging



period shall be included.

Voltage Drop; G, RE

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Special Tools and Spare Parts; G, RE

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software; G, RE

Technical data which relates to computer software.

Training; G, RE

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; G, RE

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

#### SD-06 Test Reports

Testing; G, RE

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

#### SD-07 Certificates

Equipment; G, RE

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

### Qualifications; G, RE

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

### SD-10 Operation and Maintenance Data

#### Technical Data and Computer Software; G, RE

Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

### 1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

### 1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

### 1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

### 1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

### 1.3.7 Qualifications

#### 1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

#### 1.3.7.2 Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

#### 1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

- a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.
- b. A registered professional engineer (P.E.) in fire protection engineering.
- c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.
- d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National

## Society of Fire Protection Engineers.

## 1.4 SYSTEM DESIGN

## 1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style B, to signal line circuits (SLC), Style 6, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. Provide voltage drop calculations showing circuit load and voltage drop. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC and SLC will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

- a. Sufficient memory to perform as specified and as shown for addressable system.
- b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors
- c. Capability of each addressable device being individually disabled or enabled from the panel.
- d. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

## 1.4.2 Operational Features

The system shall have the following operating features:

- a. Monitor electrical supervision of IDC, SLC, and NAC. Smoke detectors shall have combined alarm initiating and power circuits.
- b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
- c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit

used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

- d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
- e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.
- f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.
- g. Evacuation alarm silence input, when contact on mass notification system is closed, silence all audible notification devices and activate trouble signal in control panel. When contact is open, system shall operate normally.
- h. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.
- i. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.
- j. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.
- k. Provide one person test mode - Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
- l. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.
- m. The fire alarm control panel shall monitor the fire sprinkler

system, or other fire protection extinguishing system.

- n. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.

#### 1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

- a. Transmission of signals over the station radio fire reporting system. The signals shall be as follows: .
  - (1) Manual pull station;
  - (2) Smoke detectors;
  - (3) SCIF smoke detectors;
  - (4) Duct smoke detectors;
  - (5) Pre-action sprinkler system alarm;
  - (6) Sprinkler flow;
  - (7) Sprinkler trouble;
  - (8) Spare.
- b. Visual indications of the alarmed devices on the fire alarm control panel display.
- c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.
- d. Activate remote relays at card reader controllers.
- e. Deactivation of the air handling units serving the alarmed area.
- f. Automatic discharge of the designated fire suppression systems. A 15 second maximum delay shall be provided for the deluge system.

#### 1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

#### 1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

#### 1.4.6 Interface With other Equipment

Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for smoke control systems, door releases, etc.

## 1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. Software, keyed adapters, connecting cables and proprietary equipment, necessary for the maintenance, testing and reprogramming of the equipment shall be furnished to the Contracting Officer. Provisions for Manufacturer training shall be provided, if necessary, to receive proprietary software. The data package shall also include the following:

- (1) Identification of programmable portions of system equipment and capabilities.
- (2) Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
- (3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.
- (4) Description of Fire Alarm Control Panel equipment operation.
- (5) Description of auxiliary and remote equipment operations.
- (6) Library of application software.
- (7) Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

## 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

## 1.7 EQUIPMENT

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

## PART 2 PRODUCTS

### 2.1 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic,

phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and ID number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

#### 2.1.1 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

#### 2.1.2 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

#### 2.1.3 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

#### 2.1.4 Addressable Initiating Device Circuits Module

The initiating device being monitored shall be configured as a Style B initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal



identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

## 2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located at the bottom of the panel or in a separate battery cabinet. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

## 2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

## 2.4 REMOTE ANNUNCIATOR

- a. Remote annunciator shall be furnished at the location shown on the drawings. The annunciator shall operate on 24 VDC and communicate with the control panel via supervised serial communications.
- b. Annunciator shall have a backlit 40 character LCD display similar to the control panel. Annunciator front door and trim shall be painted steel.
- c. The annunciator shall be provided with a remote trouble silence, alarm silence and reset switches.
- d. Annunciators shall annunciate alarm and trouble for all building devices.

## 2.5 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on semi-flush mounted outlet boxes. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key shall be required to reset the station. Screw type reset shall not be acceptable. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually

reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

## 2.6 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

### 2.6.1 Heat Detectors

Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

#### 2.6.1.1 Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 ft.

### 2.6.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

#### 2.6.2.1 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

#### 2.6.2.2 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

#### 2.7 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red.

##### 2.7.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box recessed vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating as shown on the drawings. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

##### 2.7.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be semi-flush mounted.

##### 2.7.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

## 2.8 NOTIFICATION APPLIANCE EXTENSION PANEL

- a. Remote signal extender shall be cabinet enclosed modular unit with 2 internal signal circuits, 24 VDC power supply, battery charger and battery backup.
- b. Each signal circuit shall be supervised, 24 VDC, 2 amp rating wire individual trouble indicators for each circuit. A trouble condition on any circuit shall report to the panel. Signal circuits shall be dividable into groups.
- c. Power supply shall have 120 VAC input voltage and 24 VDC at 6 amp output.
- d. Remote signal extender shall have battery charger to charge internal batteries. Batteries shall be sized for 6 amp alarm current. Batteries shall be sealed "Gel-Cell" type.

## 2.9 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

### 2.9.1 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

### 2.9.2 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. 14 AWG minimum, 12 AWG maximum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for style 5 addressable systems.

### 2.9.3 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

## 2.10 TRANSMITTERS

### 2.10.1 Radio Alarm Transmitters

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of

NFPA 72, NFPA 1221, and 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is Monaco D500 Series and the transceiver shall be fully compatible with this equipment.

#### 2.10.1.1 Transmitter Power Supply

Each radio alarm transmitter shall be powered by a combination of locally available 120-volt ac power and a sealed, lead-calcium battery.

- a. Operation: Each transmitter shall operate from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.
- b. Battery Power: Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

#### 2.10.1.2 Radio Alarm Transmitter Housing

Transmitter housing shall be NEMA Type 1. The housing shall contain a lock that is keyed identical to radio alarm transmitter housings on the base. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

#### 2.10.1.3 Antenna

The Contractor shall provide omnidirectional for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 100 mph. Antennas shall not be mounted to any portion of the building roofing system.

### 2.11 SURGE SUPPRESSION

Provide low voltage surge suppression devices to suppress all voltage transients which might damage the control panel. Mount suppressors in separate enclosure(s) adjacent to control panel unless suppressors are specifically UL listed or FM approved for mounting inside the control panel provided and approved for such use by the control panel manufacturer.

#### 2.11.1 Line Voltage Surge Suppressor

Suppressor shall be UL 1449 listed with a maximum 330 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor shall also meet IEEE C62.41 Category B tests for surge capacity. Suppressor shall be a multi-stage construction which includes inductors and silicon avalanche zener diodes. Suppressor shall have a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components. Fuses shall be externally accessible. Wire in series with the incoming power source to the protected equipment using screw terminations.

### 2.11.2 Low Voltage Surge Suppressor

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two or more building, provide an arrestor at the circuit entrance to each building. Suppressor shall be UL 497B listed with a maximum 30 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor shall have multi-stage construction and both differential/common mode protection.

## PART 3 EXECUTION

### 3.1 INSTALLATION

All work shall be installed as shown, and in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

#### 3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

#### 3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

#### 3.1.3 Control Panel

Panel shall be installed to comply with the requirements of UL 864.

#### 3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops

shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided.

### 3.1.5 Addressable Initiating Device Circuits Module

The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as specified in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, as indicated on the drawings and as specified herein.

### 3.1.6 Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, as indicated on the drawings and as specified herein.

## 3.2 OVERVOLTAGE AND SURGE PROTECTION

### 3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

### 3.2.2 Low Voltage DC Circuits Surge Protection

All IDC, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge

protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

### 3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

### 3.4 SUPERVISING STATION PROVISIONS

The supervising equipment is existing and consists of the following brands and models: supervising station control panel Monaco D500 Series, and is located in Building 859.

#### 3.4.1 Revisions to Existing Facilities

Existing supervising components shall be modified as indicated on the drawings and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the revised configuration plus interfacing components operates compatibly with the new fire alarm system at the protected premises. Work on existing equipment shall be performed in accordance with the manufacturer's instructions or under supervision of the manufacturer's representative.

#### 3.4.2 Additions to Existing Facilities

Supplemental components shall be added to the existing supervising equipment as required to accommodate the new fire alarm system to be installed at the protected premises. All present functions shall be extended, including recording and storage in memory, and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the expanded configuration operates compatibly with the new fire alarm system.

### 3.5 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

#### 3.5.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.



### 3.5.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

- a. Test of each function of the control panel.
- b. Test of each circuit in both trouble and normal modes.
- c. Tests of each alarm initiating devices in both normal and trouble conditions.
- d. Tests of each control circuit and device.
- e. Tests of each alarm notification appliance.
- f. Tests of the battery charger and batteries.
- g. Complete operational tests under emergency power supply.
- h. Visual inspection of wiring connections.
- i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
- j. Ground fault.
- k. Short circuit faults.
- l. Stray voltage.
- m. Loop resistance.

### 3.6 TRAINING

Training course shall be provided for the operations and maintenance staff.

The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training day (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions.

-- End of Section --

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## SECTION 13852A

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02/02

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## SECTION 13852A

FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE - COMPANY OPERATIONS FACILITY  
**02/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S3.41 (1990; R 1996) Audible Emergency  
Evacuation Signal

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1221 (1999) Installation, Maintenance and Use  
of Public Fire Service Communication  
Systems

NFPA 70 (2002) National Electrical Code

NFPA 72 (2002) National Fire Alarm Code

NFPA 90A (2002) Installation of Air Conditioning  
and Ventilating Systems

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## UNDERWRITERS LABORATORIES (UL)

UL 1449 (1996; Rev thru Jul 2002) Transient  
Voltage Surge Suppressors

UL 1242 (1996; Rev Mar 1998) Intermediate Metal  
Conduit

UL 1971 (1995; Rev thru Apr 1999) Signaling  
Devices for the Hearing Impaired

UL 268 (1996; Rev thru Jan 1999) Smoke Detectors  
for Fire Protective Signaling Systems

UL 268A (1998) Smoke Detectors for Duct Application

UL 38	(1999) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 464	(1996; Rev thru May 1999) Audible Signal Appliances
UL 497B	(1999) Safety Protectors for Data Communication and Fire Alarm Circuits
UL 521	(1999) Heat Detectors for Fire Protective Signaling Systems
UL 6	(1997) Rigid Metal Conduit
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 864	(1996; Rev thru Mar 1999) Control Units for Fire Protective Signaling Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Fire Alarm Reporting System; G, RE

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

### SD-03 Product Data

#### Storage Batteries; G, RE

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging

period shall be included.

Voltage Drop; G, RE

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Special Tools and Spare Parts; G, RE

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software; G, RE

Technical data which relates to computer software.

Training; G, RE

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; G, RE

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

#### SD-06 Test Reports

Testing; G, RE

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

#### SD-07 Certificates

Equipment; G, RE

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

### Qualifications; G, RE

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

### SD-10 Operation and Maintenance Data

#### Technical Data and Computer Software; G, RE

Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

### 1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

### 1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

### 1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

### 1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

### 1.3.7 Qualifications

#### 1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

#### 1.3.7.2 Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

#### 1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

- a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.
- b. A registered professional engineer (P.E.) in fire protection engineering.
- c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.
- d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National



## Society of Fire Protection Engineers.

## 1.4 SYSTEM DESIGN

## 1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style B, to signal line circuits (SLC), Style 6, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. Provide voltage drop calculations showing circuit load and voltage drop. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC and SLC will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

- a. Sufficient memory to perform as specified and as shown for addressable system.
- b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors
- c. Capability of each addressable device being individually disabled or enabled from the panel.
- d. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

## 1.4.2 Operational Features

The system shall have the following operating features:

- a. Monitor electrical supervision of IDC, SLC, and NAC. Smoke detectors shall have combined alarm initiating and power circuits.
- b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
- c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit

used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

- d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
- e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.
- f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.
- g. Evacuation alarm silence input, when contact on mass notification system is closed, silence all audible notification devices and activate trouble signal in control panel. When contact is open, system shall operate normally.
- h. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.
- i. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.
- j. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.
- k. Provide one person test mode - Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.
- l. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.
- m. The fire alarm control panel shall monitor and control the fire

sprinkler system, or other fire protection extinguishing system.

- n. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.

#### 1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

- a. Transmission of signals over the station radio fire reporting system. The signals shall be as follows:
  - (1) Manual pull station;
  - (2) Smoke detectors;
  - (3) Duct smoke detectors;
  - (4) Sprinkler flow;
  - (5) Sprinkler trouble;
  - (6) Spare;
  - (7) Spare;
  - (8) Spare.
- b. Visual indications of the alarmed devices on the fire alarm control panel display and on the remote audible/visual display.
- c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.
- d. Deactivation of the air handling units serving the alarmed area.

#### 1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

#### 1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

#### 1.4.6 Interface With other Equipment

Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for smoke control systems, door releases, etc.

### 1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and

which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. Software, keyed adapters, connecting cables and proprietary equipment, necessary for the maintenance, testing and reprogramming of the equipment shall be furnished to the Contracting Officer. Provisions for Manufacturer training shall be provided, if necessary, to receive proprietary software. The data package shall also include the following:

- (1) Identification of programmable portions of system equipment and capabilities.
- (2) Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
- (3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.
- (4) Description of Fire Alarm Control Panel equipment operation.
- (5) Description of auxiliary and remote equipment operations.
- (6) Library of application software.
- (7) Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

#### 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

#### 1.7 EQUIPMENT

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

### PART 2 PRODUCTS

#### 2.1 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single

operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

#### 2.1.1 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

#### 2.1.2 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

#### 2.1.3 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

#### 2.1.4 Addressable Initiating Device Circuits Module

The initiating device being monitored shall be configured as a Style B initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

## 2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located at the bottom of the panel or in a separate battery cabinet. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

## 2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

## 2.4 REMOTE ANNUNCIATOR (SERIAL)

- a. Remote annunciators shall be furnished at the location shown on the drawings. The annunciate shall operate on 24 VDC and communicate with the control panel via supervised serial communications.
- b. Annunciator shall have a backlit 40 character LCD display similar to the control panel. Annunciator front door and trim shall be painted steel.
- c. The annunciator shall be provided with a remote trouble silence, alarm silence and reset switches.
- d. Annunciators shall annunciate alarm and trouble for all building devices.

## 2.5 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on semi-flush mounted outlet boxes. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key shall be required to reset the station. Screw type reset is not acceptable. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

## 2.6 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

### 2.6.1 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

#### 2.6.1.1 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

#### 2.6.1.2 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. The

detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

## 2.7 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red.

### 2.7.1 Speakers

- a. Flush, ceiling mounted, cone type speakers shall be 4 inches diameter with an output of 90 dB-SPL minimum at four foot with one watt input, under anechoic conditions. Speakers shall be cone-type, fire retardant, moisture proof and UL Listed for fire alarm service. Furnish wall mounted with square baffle or ceiling mounted with round baffle. Speaker shall be furnished with supervisory capacitor, matching tapped transformer, and back can. All components shall be supported from grid work or structure. Do not support speaker from ceiling tile.
- b. Semi-flush, wall mounted horn speakers shall be compression driver type, with a short, re-entry horn. Unit shall be capable of 90 dBA-SPL at 10 feet with one watt input power.
- c. Ceiling mounted, horn type speakers shall be compression driver type with 110 re-entrant horn. Unit shall be capable of producing 101 dB-SPL at 10 feet with one watt input power.
- d. All speakers shall be UL Listed for emergency warning systems per NFPA 72F and be provided with matching transformers and capacitors for proper operation and supervision by the control and amplification equipment. All speaker wiring connections shall be in flexible metal conduit, UL Listed for grounding or provided with a bonded grounding conductor.

### 2.7.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be surface mounted.

### 2.7.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

### 2.7.4 Voice Evacuation System

The voice evacuation system shall provide for one-way voice communications, routing and pre-amplification of digital alarm tones and voice (digital and



analog) messages. The system shall be zoned for messages (Custom and prerecorded) and tones as indicated on the drawings. The following electronic tones shall be available from the amplifier: Slow Whoop, High/Low, Horn, Chime, Beep, Stutter, Wail and Bell. The system shall have a microphone and allow for general paging within the space. Operation shall be either manually from a control switch or automatically from the fire alarm control panel. Reset shall be accomplished by the fire alarm control panel during panel reset.

## 2.8 NOTIFICATION APPLIANCE EXTENSION PANEL

- a. Remote signal extender shall be cabinet enclosed modular unit with 2 internal signal circuit, 24 VDC power supply, battery charger and battery backup.
- b. Each signal circuit shall be supervised, 24 VDC, 2 amp rating wire individual trouble indicators for each circuit. Trouble condition on any circuit shall report to the panel. Signal circuits shall be dividable into groups.
- c. Power supply shall have 120 VAC input voltage and 24 VDC at 6 amp output.
- d. Remote signal extender shall have battery charger to charge internal batteries. Batteries shall be sized for 6 amp alarm current. Batteries shall be sealed "Gel-Cell" type.

## 2.9 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

### 2.9.1 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

### 2.9.2 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. 14 AWG minimum, 12 AWG maximum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for style 5 addressable systems.

### 2.9.3 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

## 2.10 TRANSMITTERS

### 2.10.1 Radio Alarm Transmitters

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, NFPA 1221, and 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is Monaco D500 Series and the transceiver shall be fully compatible with this equipment.

#### 2.10.1.1 Transmitter Power Supply

Each radio alarm transmitter shall be powered by a combination of locally available 120-volt ac power and a sealed, lead-calcium battery.

- a. Operation: Each transmitter shall operate from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.
- b. Battery Power: Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

#### 2.10.1.2 Radio Alarm Transmitter Housing

Transmitter housing shall be NEMA Type 1. The housing shall contain a lock that is keyed identical to radio alarm transmitter housings on the base. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

#### 2.10.1.3 Antenna

The Contractor shall provide omnidirectional for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 100 mph. Antennas shall not be mounted to any portion of the building roofing system.

## 2.11 SURGE SUPPRESSION

Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel components. Mount suppressors in separate enclosure(s) adjacent to control panel unless suppressors are specifically UL listed or FM approved for mounting inside the control panel provided and approved for such use by the control panel manufacturer.

### 2.11.1 Line Voltage Surge Suppressor

Suppressor shall be UL 1449 listed with a maximum 330 volt clamping level

and a maximum response time of 5 nanoseconds. Suppressor shall also meet IEEE C62.41 category B tests for surge capacity. Suppressor shall be a multi-stage construction which includes inductors and silicon avalanche zener diodes. Suppressor shall have a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components. Fuses shall be externally accessible. Wire in series with the incoming power source to the protected equipment using screw terminations.

#### 2.11.2 Low Voltage Surge Suppressor

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two or more buildings, provide an arrestor at the circuit entrance to each building. Suppressor shall be UL 497B listed with a maximum 30 volt clamping level and a maximum response time of 5 nanoseconds. Suppressor shall have multi-stage construction and both differential/common mode protection.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

All work shall be installed as shown, and in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

##### 3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

##### 3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

##### 3.1.3 Control Panel

Panel shall be installed to comply with the requirements of UL 864.

#### 3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided.

#### 3.1.5 Addressable Initiating Device Circuits Module

The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as specified in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, as indicated on the drawings and as specified herein.

#### 3.1.6 Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, as indicated on the drawings and as specified herein.

### 3.2 OVERVOLTAGE AND SURGE PROTECTION

#### 3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected

from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

### 3.2.2 Low Voltage DC Circuits Surge Protection

All IDC, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

### 3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

### 3.4 SUPERVISING STATION PROVISIONS

The proprietary type Supervising Station (PSS) is located in Building 859. The supervising equipment is existing and consists of the following brands and models: supervising station control panel Monaco D500 Series.

#### 3.4.1 Revisions to Existing Facilities

Existing supervising components shall be modified as indicated on the drawings and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the revised configuration plus interfacing components operates compatibly with the new fire alarm system at the protected premises. Work on existing equipment shall be performed in accordance with the manufacturer's instructions or under supervision of the manufacturer's representative.

#### 3.4.2 Additions to Existing Facilities

Supplemental components shall be added to the existing supervising equipment as required to accommodate the new fire alarm system to be installed at the protected premises. All present functions shall be extended, including recording and storage in memory, and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the expanded configuration operates compatibly with the new fire alarm system.

### 3.5 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

#### 3.5.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to

functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

### 3.5.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

- a. Test of each function of the control panel.
- b. Test of each circuit in both trouble and normal modes.
- c. Tests of each alarm initiating devices in both normal and trouble conditions.
- d. Tests of each control circuit and device.
- e. Tests of each alarm notification appliance.
- f. Tests of the battery charger and batteries.
- g. Complete operational tests under emergency power supply.
- h. Visual inspection of wiring connections.
- i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
- j. Ground fault.
- k. Short circuit faults.
- l. Stray voltage.
- m. Loop resistance.

### 3.6 TRAINING

Training course shall be provided for the operations and maintenance staff.

The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training day (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance

instructions.

-- End of Section --

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## SECTION 13853

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## SECTION 13853

## MASS NOTIFICATION SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 72 (2002) National Fire Alarm Code

## UNDERWRITERS LABORATORIES (UL)

UL 1242 (1996; Rev Mar 1998) Intermediate Metal  
Conduit

UL 1971 (1995; Rev thru Apr 1999) Signaling  
Devices for the Hearing Impaired

UL 464 (1996; Rev thru May 1999) Audible Signal  
Appliances

UL 6 (1997) Rigid Metal Conduit

UL 797 (1993; Rev thru Mar 1997) Electrical  
Metallic Tubing

UL 864 (1996; Rev thru Mar 1999) Control Units  
for Fire Protective Signaling Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Mass Notification System; G, RE

Detail drawings, prepared and signed by a Registered

Professional Engineer or a NICET Level 3 Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

#### SD-03 Product Data

##### Storage Batteries; G, RE

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

##### Voltage Drop; G, RE

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

##### Special Tools and Spare Parts; G, RE

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

##### Technical Data and Computer Software; G, RE

Technical data which relates to computer software.

##### Training; G, RE

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the MNS (mass notification system). The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

##### Testing; G, RE

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the MNS system 60 days prior to performing system tests.

## SD-06 Test Reports

Testing; G, RE

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

## SD-07 Certificates

Equipment; G, RE

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications; G, RE

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

## SD-10 Operation and Maintenance Data

Technical Data and Computer Software; G, RE

Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

## 1.3 GENERAL REQUIREMENTS

## 1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 1 year prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

## 1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a

noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

#### 1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

#### 1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

#### 1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.3.6 Compliance

The mass notification system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

#### 1.3.7 Qualifications

##### 1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

##### 1.3.7.2 Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

## 1.4 SYSTEM DESIGN

### 1.4.1 Operation

The mass notification system shall be a complete, voice/visual evacuation system. The system shall provide live and pre-recorded announcements. Notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all NAC will remain functional. Audible and visual appliances and systems shall comply with NFPA 72. Provide voltage drop calculations showing circuit load and voltage drop. System components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. System shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

- a. Sufficient memory to perform as specified and as shown for addressable system.
- b. Individual identity of each NAC for the following conditions: trouble; open; and short.

### 1.4.2 Operational Features

The system shall have the following operating features:

- a. Monitor electrical supervision of NAC.
- b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of modules (card, PC board).
- c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of modules (card, PC board). A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
- d. The mass notification system panel shall provide supervised addressable relays for fire alarm system deactivation.
- e. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or NAC; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.
- f. Zones for NAC shall be arranged as indicated on the contract drawings.

#### 1.4.3 Voice Announcements

- a. Initiation of voice announcements shall signal the fire alarm system audio and visual notification appliances to silence. When the voice announcement is complete, the fire alarm system audio and visual notification appliances shall return to normal operation.
- b. Initiation of live voice announcements from the remote or local microphone shall interrupt all automatic signals without delay. Each evacuation zone shall be manually selectable on an individual or all call basis.
- c. Initiation of pre-recorded voice announcements shall automatically select all zones and playback the selected message. Each of the five 60-second messages shall be individually selectable from switches located at the local or remote microphones. Messages shall repeat until the selection switch is turned off. Messages shall be stored in non-volatile solid state memory and messages shall be as determined by Physical Security.
- d. Initiation of paging announcements from telephone system.

#### 1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

#### 1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

#### 1.4.6 Interface With Fire Alarm System

Interfacing components shall be furnished as required to connect to the fire alarm system, such as alarm contacts for deactivation of the fire alarm system notification devices.

### 1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

- (1) Identification of programmable portions of system equipment and capabilities.

- (2) Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
- (3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.
- (4) Description of control panel equipment operation.
- (5) Description of auxiliary and remote equipment operations.
- (6) Library of application software.
- (7) Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

#### 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

#### 1.7 EQUIPMENT

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

### PART 2 PRODUCTS

#### 2.1 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each circuit. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment.

If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted beige.



### 2.1.1 Remote Operator Console

Panel shall house supervised remote microphone, zone selector switches and message selector switches. Panel shall be modular, installed in a steel cabinet with hinged door, and cylinder lock. All LED/LDC displays shall be visible through the cabinet door. A rigid plastic, phenolic or metal identification sign which reads "MASS NOTIFICATION SYSTEM REMOTE MICROPHONE" shall be provided at the remote operator console.

### 2.1.2 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

### 2.1.3 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

## 2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the system for a period of 72 hours (Company Operations Facility). Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 30 minutes. Batteries shall be located at the bottom of the panel or in a separate battery cabinet. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

## 2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

## 2.4 REMOTE PANEL

Remote panel shall be a scale amplifier and notification appliance circuits. Provide battery charger and batteries. Panel audio input shall be the control panel. Remote panel shall have no operator controls; all functions shall be controlled from the main panel. Panel shall be enclosed in a cabinet similar to the control panel cabinet.

## 2.5 NOTIFICATION APPLIANCE EXTENSION PANEL

- a. Remote signal extender shall be cabinet enclosed modular unit with two internal signal circuits, 24 VDC power supply, battery charger

and battery backup.

- b. Each signal circuit shall be supervised, 24 VDC, 2 amp rating wire individual trouble indicators for each circuit. A trouble condition on any circuit shall report to the panel. Signal circuits shall be dividable into groups.
- c. Power supply shall have 120 VAC input voltage and 24 VDC at 6 amp output.
- d. Remote signal extender shall have battery charger to charge internal batteries. Batteries shall be sized for 6 amp alarm current. Batteries shall be sealed "Gel-Cell" type.

## 2.6 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted white.

### 2.6.1 Speakers

- a. Flush, ceiling mounted, cone type speakers shall be 4 inches diameter with an output of 90 dB-SPL minimum at four foot with watt input, under anechoic conditions. Speakers shall be cone-type, fire retardant, moisture proof and UL listed for fire alarm service. Furnish ceiling mounted speakers with round baffle. Speaker shall be furnished with supervisory capacitor, matching tapped transformer, and back can. All components shall be supported from grid work or structure. Do not support speaker from ceiling tile.
- b. Surface, ceiling mounted, horn type, weatherproof speakers shall be compression driver type with 110 re-entrant horn. Unit shall be capable of producing 101 dB-SPL at 10 feet with one (1) watt input power.
- c. All speakers shall be UL listed for emergency warning systems and be provided with matching transformers and capacitors for proper operation and supervision by the control and amplification equipment. All speaker wiring connections shall be in flexible metal conduit, UL listed for grounding or provided with a bonded grounding conductor.

### 2.6.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 15 candela unless shown higher on the drawings. Strobe shall be semi-flush mounted.

### 2.6.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same

requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

#### 2.6.4 Single Zone Telephone Paging Adapter

Telephone paging adapter will interface with telephone system and automatically answer telephone calls to the extension line. When the extension for the telephone paging adapter is called, the adapter will pickup and produce a preannounce tone. Telephone paging adapter shall also have the following minimum features:

- a. Paging adapter shall have background music input. Telephone line connection types shall be provided for loop-start and ground-start trunks. Background music input volume shall have level adjustments.
- b. Output shall be 600 ohms, line level. Provide power supply for 120 VAC operation. Telephone paging adapter shall be FCC registered.
- c. Provide one telephone paging adapter for each mass notification zone. Program zones as shown on drawings.

#### 2.6.5 End Station Adapter

End station adapter shall provide ring trip and page access for standard telephone lines. End station adapter shall have the following minimum features:

- a. Access Methods: Centrex, loop start and PABX station.
- b. Resets: Open loop, audio sense, time out, manual.
- c. Tones: Answer verification and all call override.
- d. Rack mount on back of plank plate.

#### 2.6.6 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

#### 2.6.7 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. Wiring for fire alarm dc circuits shall be No. 12 AWG maximum and 14 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to notification appliance circuits are prohibited.

#### 2.6.8 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required

shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

All work shall be installed as shown, and in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

##### 3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

##### 3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

##### 3.1.3 Control Panel

Panel shall be installed to comply with the requirements of UL 864.

#### 3.2 OVERVOLTAGE AND SURGE PROTECTION

##### 3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

##### 3.2.2 Signal Line Circuit Surge Protection

All SLC cables/conductors shall have surge protection/isolation circuits installed at each point where it exits or enters a building. The circuit shall be protected from surges per IEEE C62.41 B3 combination waveform and

NFPA 70. The surge protector/isolator shall be rated to protect the equipment.

### 3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

### 3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

#### 3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

#### 3.4.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

- a. Test of each function of the control panel.
- b. Test of each circuit in both trouble and normal modes.
- c. Tests of each control circuit and device.
- d. Tests of each notification appliance.
- e. Tests of the battery charger and batteries.
- f. Complete operational tests under emergency power supply.
- g. Visual inspection of wiring connections.
- h. Opening the circuit at each notification appliance to test the wiring supervisory feature.
- i. Ground fault.
- j. Short circuit faults.

k. Stray voltage.

l. Loop resistance.

### 3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system.

-- End of Section --

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## SECTION 13921A

PACKAGED FIRE PUMP WITH ENCLOSURE  
**01/04**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1999) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA EWW	(1998) Standard Methods for the Examination of Water and Wastewater
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

## ASME INTERNATIONAL (ASME)

ASME B16.18	(2002) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings

## ASTM INTERNATIONAL (ASTM)

ASTM A 183	(2003) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(2003) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 449	(2000) Quenched and Tempered Steel Bolts and Studs
ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 536	(1984; R 1999e1) Ductile Iron Castings
ASTM A 795	(2000) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B 135	(2002) Seamless Brass Tube
ASTM B 42	(2002) Seamless Copper Pipe, Standard Sizes
ASTM B 62	(2002) Composition Bronze or Ounce Metal Castings
ASTM B 75	(2002) Seamless Copper Tube
ASTM B 88	(2002) Seamless Copper Water Tube
ASTM D 2000	(2001) Rubber Products in Automotive Applications
ASTM D 3308	(2001) PTFE Resin Skived Tape
ASTM F 436	(2003) Hardened Steel Washers

## FM GLOBAL (FM)

FM P7825a	(2003) Approval Guide Fire Protection
FM P7825b	(2003) Approval Guide Electrical Equipment

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2002) Installation of Sprinkler Systems
NFPA 1963	(2003) Fire Hose Connections
NFPA 20	(2003) Installation of Stationary Pumps for Fire Protection
NFPA 24	(2002) Installation of Private Fire Service Mains and Their Appurtenances

NFPA 70

(2002) National Electrical Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES  
(NICET)

NICET 1014-7

(1995) Program Detail Manual for  
Certification in the Field of Fire  
Protection Engineering Technology (Field  
Code 003) Subfield of Automatic Sprinkler  
System Layout

UNDERWRITERS LABORATORIES (UL)

UL 448

(1994; Rev thru May 1999) Pumps for  
Fire-Protection Service

UL Fire Prot Dir

(2003) Fire Protection Equipment Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Installation Requirements; G, RE

Three copies of the Fire Pump Installation Drawings consisting of a detailed plan view, detailed elevations and sections of the packaged pump and enclosure, equipment and piping, drawn to a scale of not less than 1/2 inch = 1 foot. Drawings shall indicate equipment, piping, and associated pump equipment to scale. All clearance, such as those between piping and equipment; between equipment and walls, ceiling and floors; and for electrical working distance clearance around all electrical equipment shall be indicated. Submittal shall include location and size of each field connection consistent with packaged pump utility outlets and inlets. Drawings shall include a legend identifying all symbols, nomenclatures, and abbreviations. Drawings shall indicate a complete piping and equipment layout including elevations and/or section views of the following:

- a. Fire pumps, controllers, piping, valves, and associated equipment.
- b. Sensing line for each pump including the pressure maintenance pump.
- c. Restraint of underground water main at entry-and exit-points to the enclosure pad including details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.
- d. A one-line schematic diagram indicating layout and sizes of all piping, devices, valves and fittings.

e. A complete point-to-point connection drawing of the pump power, control and alarm systems, as well as interior wiring schematics of each controller.

#### As-Built Drawings

As-built drawings, as specified.

#### SD-03 Product Data

##### Fire Pump Installation Related Submittals

A list of the Fire Pump Installation Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist and the Manufacturer's Representative.

##### Installation Requirements; G, RE

Manufacturer's catalog data included with the Packaged Fire Pump and Enclosure Installation Drawings for each separate piece of equipment proposed for use in the system. Catalog data shall indicate the name of the manufacturer of each item of equipment, with data annotated to indicate model to be provided. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided. Catalog data for material and equipment shall include, but not be limited to, the following:

a. Fire pumps, skid mounting, drivers and controllers including manufacturer's certified shop test characteristic curve for each pump. Shop test curve may be submitted after approval of catalog data but shall be submitted prior to the final tests.

b. Pressure maintenance pump and controller.

c. Piping components.

d. Valves, including gate, check, globe and relief valves.

e. Gauges.

f. Hose valve manifold test header and hose valves.

g. Restrictive orifice union.

h. Associated devices and equipment.

i. Enclosure, including heating, ventilation, lighting and sprinkler equipment.

#### Spare Parts

Spare parts data for each different item of material and equipment specified.

#### Factory Tests

Notify Resident Office 21 days ahead of factory performance testing of packaged pump assembly including controllers.

Arrangements shall be made to allow a Government Representative to witness performance tests.

#### Preliminary Test

Proposed procedures for Preliminary Tests at site, at least 14 days prior to the proposed start of the tests.

Proposed date and time to begin Preliminary Tests, submitted with the Preliminary Tests Procedures.

#### Field Tests; G, RE

Proposed diagrams, at least 2 weeks prior to start of related testing.

#### Fire Protection Specialist; G, RE

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings.

#### Manufacturer's Representative; G, RE

The name and documentation of certification of the proposed Manufacturer's Representative, concurrent with submittal of the Fire Protection Specialist Qualifications.

#### Field Training; G, RE

Proposed schedule for field training submitted at least 14 days prior to the start of related training.

#### Final Acceptance Test

Proposed date and time to begin Final Acceptance Test, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

Proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests.

### SD-06 Test Reports

#### Factory Tests; G, RE

Three copies of complete performance test results no later than 14 days after completion of tests.

#### Preliminary Site Test; G, RE

Three copies of the completed Preliminary Site Tests Reports, no later than 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping.

All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist and the Manufacturer's Representative.

Final Acceptance Test; G, RE

Three copies of the completed Final Acceptance Tests Reports, no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist and the Manufacturer's Representative. Test reports in booklet form (each copy furnished in a properly labeled three ring binder) showing all field tests and measurements taken during the preliminary and final testing, and documentation that proves compliance with the specified performance criteria, upon completion of the installation and final testing of the installed system. Each test report shall indicate the final position of the controls and pressure switches.

The test reports shall include the description of the hydrostatic test conducted on the piping and flushing of the suction and discharge piping. A copy of the manufacturer's certified pump curve for each fire pump shall be included in the report.

#### SD-07 Certificates

Fire Protection Specialist; G, RE

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the packaged fire pump installation is in accordance with the contract requirements, including signed approval of the Factory Preliminary and Final Acceptance Test Reports.

#### SD-10 Operation and Maintenance Data

Packaged Fire Pump with Enclosure

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

### 1.3 GENERAL REQUIREMENTS

- a. Packaged fire pump with enclosure shall include factory fabricated and tested skid mounted pump assembly with weathertight enclosure. Enclosure shall include lights, heating, ventilation, sprinklers and associated supplies and controls.
- b. Except as modified in this Section or on the drawings, fire pumps shall be installed in conformance with NFPA 20, including all recommendations and advisory portions, which shall be considered mandatory. All reference to the authority having jurisdiction shall be interpreted to mean the Contracting Officer.

- c. The Contractor shall submit Spare Parts data for each different item of equipment and material specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

#### 1.4 SEQUENCE OF OPERATION

##### 1.4.1 Fire Pump

Fire pump shall automatically operate when the pressure drops to 75 psi. The fire pump shall automatically stop operating when the system pressure reaches 90 psi and after the fire pump has operated for the minimum pump run time specified herein.

##### 1.4.1.1 Pressure Maintenance Pump

Pressure maintenance pump shall operate when the system pressure drops to 80 psi. Pump shall automatically stop when the system pressure reaches 90 psi and after the pump has operated for the minimum pump run time specified herein.

##### 1.4.2 Safety Requirements

Coupling, rotating parts, gears, projecting equipment, etc. shall be fully enclosed or properly guarded so as to prevent possible injury to persons that come in close proximity of the equipment. The Contractor shall conduct testing of the fire pumps in a safe manner and ensure that all equipment is safely secured. Hoses and nozzles used to conduct flow tests shall be in excellent condition and shall be safely anchored and secured to prevent any misdirection of the hose streams.

#### 1.5 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as specified to provide a complete installation and to eliminate interference with other construction.

#### 1.6 DELIVERY AND STORAGE

The packaged pump and enclosure, when delivered, shall be protected from the weather, dirt and dust, or other contaminants. Additionally, all pipes shall be either capped or plugged until installed.

#### 1.7 FIELD MEASUREMENTS

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.8 FIRE PROTECTION SPECIALIST

Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is



certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.9 MANUFACTURER'S REPRESENTATIVE

Work specified in this section shall be performed under the supervision of and certified by a representative of the fire pump manufacturer. The Manufacturer's Representative shall be regularly engaged in the installation of the type and complexity of fire pump(s) specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.10 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number. Pumps and motors shall have standard nameplates securely affixed in a conspicuous place and easy to read. Fire pump shall have nameplates and markings in accordance with UL 448. Electric motor nameplates shall provide the minimum information required by NFPA 70, Section 430-7.

#### 2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

## 2.4 UNDERGROUND PIPING COMPONENTS

### 2.4.1 Pipe and Fittings

Underground piping and piping under the enclosure slab shall be ductile iron with a rated working pressure of 150 psi conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feet outside the building walls shall comply with Section 02510A WATER DISTRIBUTION SYSTEM.

### 2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

## 2.5 ABOVEGROUND PIPING COMPONENTS

### 2.5.1 Pipe Sizes 2.5 inches and Larger

#### 2.5.1.1 Pipe

Piping shall be ASTM A 795, Weight Class STD (Standard), Schedule 40 (except for Schedule 30 for pipe sizes 8 inches and greater in diameter), Type E or Type S, Grade A; black steel pipe. Steel pipe shall be joined by means of flanges welded to the pipe or mechanical grooved joints only. Piping shall not be jointed by welding or weld fittings. Suction piping shall be galvanized on the inside per NFPA 20.

#### 2.5.1.2 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

#### 2.5.1.3 Flanges

Flanges shall be ASME B16.5, Class 150 flanges. Flanges shall be provided at valves, connections to equipment, and where indicated.

#### 2.5.1.4 Gaskets

Gaskets shall be AWWA C111, cloth inserted red rubber gaskets.

#### 2.5.1.5 Bolts

Bolts shall be ASTM A 449, Type 1. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

#### 2.5.1.6 Nuts

Nuts shall be ASTM A 193/A 193M, Grade 5.

#### 2.5.1.7 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provided under all bolt heads and nuts.

#### 2.5.2 Piping Sizes 2 inches and Smaller

##### 2.5.2.1 Steel Pipe

Steel piping shall be ASTM A 795, Weight Class STD (Standard), Schedule 40, Type E or Type S, Grade A, zinc-coated steel pipe with threaded end connections. Fittings shall be ASME B16.39, Class 150, zinc-coated threaded fittings. Unions shall be ASME B16.39, Class 150, zinc-coated unions.

##### 2.5.2.2 Copper Tubing

Copper tubing shall be ASTM B 88, Type L or K, soft annealed. Fittings shall be ASME B16.26, flared joint fittings. Pipe nipples shall be ASTM B 42 copper pipe with threaded end connections.

#### 2.5.3 Pipe Hangers and Supports

Pipe hangers and support shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b and shall be the adjustable type. Finish of rods, nuts, washers, hangers, and supports shall be zinc-plated after fabrication.

#### 2.5.4 Valves

Valves shall be UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire protection service. Valves shall have flange or threaded end connections.

##### 2.5.4.1 Gate Valves and Control Valves

Gate valves and control valves shall be outside screw and yoke (O.S.&Y.) type which open by counterclockwise rotation. Butterfly-type control valves are not permitted.

##### 2.5.4.2 Tamper Switch

The suction control valves, the discharge control valves, valves to test header, and the by-pass control valves shall be equipped with valve tamper switches for monitoring by the fire alarm system.

##### 2.5.4.3 Check Valve

Check valve shall be clear open, swing type check valve with flange or threaded inspection plate.

##### 2.5.4.4 Relief Valve

Relief valve shall be spring operated type conforming to NFPA 20. A means of detecting water motion in the relief lines shall be provided where the discharge is not visible within the pump enclosure.

##### 2.5.4.5 Circulating Relief Valve

An adjustable circulating relief valve shall be provided for each fire pump

in accordance with NFPA 20.

## 2.6 PACKAGED FIRE PUMP

Fire pump shall be electric motor driven. The pump capacity shall be rated at 750 gpm with a rated net pressure of 40 psi. Fire pump shall furnish not less than 150 percent of rated flow capacity at not less than 65 percent of rated net pressure. Pump shall be centrifugal horizontal split case fire pump. Horizontal pump shall be equipped with automatic air release devices. The maximum rated pump speed shall be 2100 rpm when driving the pump at rated capacity. Pump shall conform to the requirements of UL 448. Fire pump discharge and suction gauges shall be oil-filled type.

## 2.7 ELECTRIC MOTOR DRIVER

Motor shall conform to NEMA MG 1 and be marked as complying with NEMA Design B standards. Motor horsepower shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. The motor and fire pump controller shall be fully compatible. Motor electrical characteristics shall be 460 volts, 3-phase, 60 cycle.

## 2.8 FIRE PUMP CONTROLLER

Controller shall be the automatic type and UL listed UL Fire Prot Dir or FM approved FM P7825a and FM P7825b for fire pump service. Pump shall be arranged for automatic start and stop, and manual push-button stop. Automatic stopping shall be accomplished only after all starting causes have returned to normal and after a minimum pump run time has elapsed. Controllers shall be completely terminally wired, ready for field connections, and mounted in a NEMA Type 1 enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. Controller shall be provided with voltage surge arresters installed per NFPA 20. Controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light. Controller shall be equipped with a thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F. The controller shall be factory-equipped with a heater operated by thermostat to prevent moisture in the cabinet.

### 2.8.1 Controller for Electric Motor Driven Fire Pump

Controller shall be wye-delta, open circuit transition starting type. Controller shall be designed for 25 HP at 460 volts. Controller shall have a short circuit rating as indicated. Controller shall monitor pump running, loss of a phase or line power, phase reversal, and pump room temperature. Alarms shall be individually displayed in front of panel by lighting of visual lamps. Each lamp shall be labeled with rigid etched plastic labels. Controller shall be equipped with terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature), and for remote start. Limited service fire pump controllers are not permitted, except for fire pumps driven by electric motors rated less than 15 hp. Controller shall be equipped with a 7-day electric pressure recorder with 24-hour spring wound back-up. The pressure recorder shall provide a readout of the system pressure from 0 to 15 hp, time, and date. Controller shall require the pumps to run for ten minutes for pumps with

driver motors under 200 horsepower and for 15 minutes for pumps with motors 200 horsepower and greater, prior to automatic shutdown. The controller shall be equipped with an externally operable isolating switch which manually operates the motor circuit. Means shall be provided in the controller for measuring current for all motor circuit conductors.

## 2.9 PRESSURE SENSING LINE

A completely separate pressure sensing line shall be provided for the fire pump and for the jockey pump. The sensing line shall be arranged in accordance with Figure A-7-5.2.1. of NFPA 20. The sensing line shall be 1/2 inch H58 brass tubing complying with ASTM B 135. The sensing line shall be equipped with two restrictive orifice unions each. Restricted orifice unions shall be ground-face unions with brass restricted diaphragms drilled for a 3/32 inch. Restricted orifice unions shall be mounted in the horizontal position, not less than 5 feet apart on the sensing line. Two test connections shall be provided for each sensing line. Test connections shall consist of two brass 1/2 inch globe valves and 1/4 inch gauge connection tee arranged per NFPA 20. One of the test connections shall be equipped with a 0 to 300 psi water oil-filled gauge. Sensing line shall be connected to the pump discharge piping between the discharge piping control valve and the check valve.

## 2.10 PRESSURE MAINTENANCE PUMP

Pressure maintenance pump shall be electric motor driven, in-line centrifugal type with a rated discharge of 10 gpm at 125 psig. Pump shall draft from the suction supply side of the suction pipe gate valve of the fire pump and shall discharge into the system at the downstream side of the pump discharge gate valve. An approved indicating gate valve of the outside screw and yoke (O.S.&Y.) type shall be provided in the maintenance pump discharge and suction piping. Oil-filled water pressure gauge and approved check valve in the maintenance pump discharge piping shall be provided. Check valve shall be swing type with removable inspection plate.

### 2.10.1 Pressure Maintenance Pump Controller

Pressure maintenance pump controller shall be arranged for automatic and manual starting and stopping and equipped with a "manual-off-automatic" switch. The controller shall be completely prewired, ready for field connections, and wall-mounted in a NEMA Type 1 enclosure. The controller shall be equipped with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments for automatic starting and stopping. A sensing line shall be provided connected to the pressure maintenance pump discharge piping between the control valve and the check valve. The sensing line shall conform to paragraph, PRESSURE SENSING LINE. The sensing line shall be completely separate from the fire pump sensing lines. An adjustable run timer shall be provided to prevent frequent starting and stopping of the pump motor. The run timer shall be set for 2 minutes.

## 2.11 JOINTS AND FITTINGS FOR COPPER TUBE

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee

joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Grooved mechanical joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 239 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183.

#### 2.12 PUMP BASE

The pump shall be mounted on a factory designed steel skid structural assembly which shall support the enclosure and all pump assembly components.

#### 2.13 WALL HYDRANT TEST HEADER

Test header shall be bronze and connected by ASME B16.5, Class 150 flange inlet connection with 2.5 inches American National Fire Hose Connection Screw Standard Threads (NH) per NFPA 1963. Each hose outlet shall be equipped with a cap and chain, and located no more than 3 feet and no less than 2 feet above grade.

#### 2.14 PIPE SLEEVE

A pipe sleeve shall be provided at each location where piping passes through the slab. Sleeves shall be grouted in position during construction. Sleeve shall be of sufficient length to pass through the entire thickness of the floor. The space between the exterior surface of the pipe and the interior surface of the sleeve shall be firmly packed with mineral wool insulation and caulk with plastic waterproof cement which will dry to a firm but pliable mass, or with a segmented elastomeric seal. Sleeves in masonry floors shall be hot-dip galvanized steel, ductile-iron, or cast-iron.

#### 2.15 DISINFECTING MATERIALS

##### 2.15.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

##### 2.15.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

#### 2.16 ENCLOSURE

The enclosure shall consist of truss and channel type construction. The enclosure shall be supplied complete with all necessary component parts to form a complete enclosure system. All parts shall be new and free from any defects or imperfections.

The enclosure supplier shall supply a complete set of enclosure erection drawings showing a step-by-step construction sequence for the erection of the enclosure. The erection drawings shall be prepared specifically for the enclosure covered by these specifications showing the location of all roof and wall accessories and the exact anchor bolt locations required for each accessory.

### 2.16.1 Design Requirements

The structure design and manufacture shall, as a minimum, conform to American Society of Civil Engineers "Minimum Design Loads for Buildings and Other Structures" and the Metal Building Manufacturers Association "Recommended Design Practices Manual". The specified "CHANNELFRAME" enclosure shall be designed to support the following loads:

Roof: 40# PSF Roof Load  
Walls: 25# PSF (100 MPH) Wind Load

### 2.16.2 Quality Assurance

The enclosure shall be manufactured and built to satisfy or exceed the National Electrical Code and is accompanied throughout production by the Manufacturers Comprehensive Quality Control Program.

The paint system on metal siding and roofing shall have a 20-year warranty on chalking and fading and 25-year warranty against peeling, cracking, or checking. Galvalume coatings have a 20-year warranty against rust perforation.

### 2.16.3 Structural

12, 14, and 16 gauge, 4-inch CHANNELFRAME galvanized steel framework for base channel, posts, girts, eave struts, purlins, post bracing and connecting plates. Roof to have 14 gauge solid web trusses. Framework to have a post and beam format with girts and purlins and with double intermediate trusses, and full trusses on both end walls which easily allows for future modifications or expansion.

### 2.16.4 Floor System

Diamond plate decking over entire floor area. 4 inches x 14 gauge perimeter base channel with 2-1/2 inches x 2-1/2 inches x 3/16 inch angle on interior side for welding to top of skid. Enclosure to have a "knock off" 2x6 wood sill for protection during transport.

### 2.16.5 Roof

Gable roof with 2-inch 12-pitch, covered with 26-gauge galvalume coated "Multi-Rib" roofing, painted with paint system in choice of standard colors. Roof to have pre-formed ridge cap, and 3-inch overhang on sides supported with full boxed eave trim.

### 2.16.6 Exterior Walls

26-gauge galvalume coated "Multi-Rib" panel, painted.

### 2.16.7 Exterior Trim

26-gauge complete enclosure trim system including eave and rake fascia, corners, base, jamb, and all openings, finished with paint finish.

### 2.16.8 Insulation System

R-14 in walls, R-21 above the ceiling, using 3 1/2 inches fiberglass batt insulation walls and 5 1/2 inches in the ceiling and 1 inch fiberglass blanket over the entire enclosure framework.

#### 2.16.9 Interior Finish

24-gauge flush fit, concealed fastener, metal liner panel on walls and ceiling with factory painted white finish (includes matching base, jamb, and header trim).

#### 2.16.10 Doors

One, 6'0" x 7'0" x 1 3/4", 18-gauge insulated steel faced double doors and 16-gauge doorframe. Doors and frame are hot dipped galvanized factory primed and painted. Hardware to include: locksets, stainless steel hinges, pivot hinges, astragals, crash chains, latchguards, thresholds, weatherstripping, watersheds, and drip caps extending 3 inches past door opening.

#### 2.16.11 Closures

Closed cell elastomer closures shall be provided at the eave line beneath the roof panel and where the trim meets the wall panel.

#### 2.16.12 Fasteners and Sealants

Shall be of the types approved for use on this type structure by the appropriate agencies and governing bodies and as covered in the Metal Building Manufacturers Association "Low Rise Building Systems Manual."

#### 2.16.13 Ventilation

One, 18 inch, 1500 CFM, exhaust fan with 30 inches x 30 inches louvered shutter, controls, and insect screen. Controlled in conjunction with intake by wall mounted thermostat.

One, 32 inches x 32 inches, louvered intake with motorized damper (120 V AC), filter rack and filter, and insect screen.

One, 32 inches x 32 inches, louvered intake with motorized damper (24V DC), filter rack and filter, insect screen, and weatherhood. Greenheck or equal. Wired to J-box with fuse, to be supplied when a diesel engine is enclosed.

#### 2.16.14 Lights

Fluorescent lights with wall switch. Lights shall be in moistureproof transparent enclosure.

#### 2.16.15 Electric Heater

Ceiling mounted electric heater with thermostat control. Heat capacity shall be 2.50 kw.

#### 2.16.16 Sprinklers

Install in accordance with NFPA 13. Provide control valve with tamper switch, check valve, and flow indicating switch. Switch shall be connected to alarm panel in company operations facility.



## PART 3 EXECUTION

### 3.1 FIRE PUMP INSTALLATION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the installation of the packaged fire pump and enclosure. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

### 3.2 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the fire pump installation periodically assure that the installation conforms to the contract requirements. The Fire Protection Specialist shall perform a thorough inspection of the fire pump installation, including visual observation of the pump while running shall be conducted. There shall be no excessive vibration, leaks (oil or water), unusual noises, overheating, or other potential problems. Inspection shall include piping and equipment clearance, access, supports, and guards. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered. The Fire Protection Specialist shall witness the preliminary and final acceptance tests and, after completion of the inspections and a successful final acceptance test, shall sign test results and certify in writing that the installation the fire pump installation is in accordance with the contract requirements.

### 3.3 INSTALLATION REQUIREMENTS

Installation, workmanship, fabrication, assembly, erection, examination, inspection and testing shall be in accordance NFPA 20, except as modified herein. In addition, the packaged fire pump and enclosure shall be installed in accordance with the written instructions of the manufacturer.

### 3.4 PIPE AND FITTINGS

Fittings shall be provided for changes in direction of piping and for all connections. Changes in piping sizes shall be made using tapered reducing pipe fittings. Bushings shall not be used.

#### 3.4.1 Cleaning of Piping

Interior and ends of piping shall be clean and free of any water or foreign material. Piping shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of the piping shall be securely closed so that no water or foreign matter will enter the pipes or fittings. Piping shall be inspected before placing in position.

#### 3.4.2 Threaded Connections

Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D 3308 and shall be applied to male threads only. Exposed ferrous pipe threads shall be provided with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 1 mil.

#### 3.4.3 Pipe Hangers and Supports

Additional hangers and supports shall be provided for concentrated loads in

aboveground piping, such as for valves and risers.

#### 3.4.4 Underground Piping

Installation of underground piping and fittings shall conform to NFPA 24. Joints shall be anchored in accordance with NFPA 24. Concrete thrust block shall be provided at elbow where pipe turns up towards floor, and the pipe riser shall be restrained with steel rods from the elbow to the flange above the floor. After installation per NFPA 24, rods and nuts shall be thoroughly cleaned and coated with asphalt or other corrosion-retard material approved by the Contracting Officer. Minimum depth of cover shall be 3 feet.

#### 3.4.5 Grooved Mechanical Joint

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.5 ELECTRICAL WORK

Electric motor and controls shall be in accordance with NFPA 20 and NFPA 70, unless more stringent requirements are specified herein or are indicated on the drawings. Electrical wiring and associated equipment shall be provided in accordance with NFPA 20 and Section 16415A ELECTRICAL WORK, INTERIOR.

#### 3.6 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

#### 3.7 FLUSHING

The fire pump suction and discharge piping shall be flushed at 120 percent of rated capacity of each pump. Where the pump installation consists of more than one pump, the flushing shall be the total quantity of water flowing when all pumps are discharging at 120 percent of their rated capacities. The new pumps may be used to attain the required flushing volume. Flushing operations shall continue until water is clear, but not less than 10 minutes. The Contractor shall submit a signed and dated flushing certificate before requesting field testing.

#### 3.8 FACTORY TESTS

Factory tests as submitted and approved.

#### 3.9 FIELD TESTS

The Contractor shall submit, at least 2 weeks before starting field tests, system diagrams that show the layout of equipment, piping, and storage

units, and typed condensed sequence of operation, wiring and control diagrams, and operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

### 3.9.1 Hydrostatic Test

Piping shall be hydrostatically tested at 225 psig for a period of 2 hours.

### 3.9.2 Preliminary Test

The Fire Protection Specialist shall take all readings and measurements. The Manufacturer's Representative and a representative of the fire pump controller manufacturer shall witness the complete operational testing of the fire pump and drivers. The fire pump controller manufacturer's representative shall each be an experienced technician employed by the respective manufacturers and capable of demonstrating operation of all features of respective components including trouble alarms and operating features. Packaged fire pump with enclosure, drivers and equipment shall be thoroughly inspected and tested to insure that the system is correct, complete, and ready for operation. Tests shall ensure that pumps are operating at rated capacity, pressure and speed. Tests shall include manual starting and running to ensure proper operation and to detect leakage or other abnormal conditions, flow testing, automatic start testing, testing of automatic settings, sequence of operation check, test of required accessories; test of pump alarms devices and supervisory signals, test of pump cooling and operational test of relief valves. Pumps shall run without abnormal noise, vibration or heating. If any component or system was found to be defective, inoperative, or not in compliance with the contract requirements during the tests and inspection, the corrections shall be made and the entire preliminary site test shall be repeated.

### 3.9.3 Final Acceptance Test

The Fire Protection Specialist shall take all readings and measurements. The Manufacturer's Representative and the fire pump controller manufacturer's representative shall witness for the final tests. The Contractor shall be responsible for repairing any damage caused by hose streams or other aspects of the test. The final acceptance test shall include the following:

#### 3.9.3.1 Flow Tests

Flow tests using the "wall hydrant" test header, hoses and playpipe nozzles shall be conducted. Flow tests shall be performed at churn (no flow), 75, 100, 125 and 150 percent capacity for each pump and at full capacity of the pump installation. Flow readings shall be taken from each nozzle by means of a calibrated pitot tube with gauge or other approved measuring equipment. Rpm, suction pressure and discharge pressure reading shall be taken as part of each flow test. Voltage and ampere readings shall taken on each phase as part of each flow test for electric-motor driven pumps.

#### 3.9.3.2 Starting Tests

Pumps shall be tested for automatic starting. Setting of the pressure switches shall be tested when pumps are operated by pressure drop. Tests may be performed by operating the test connection on the pressure sensing

lines. As a minimum, each pump shall be started automatically 10 times and manually 10 times, in accordance with NFPA 20. Tests of engine-driven pumps shall be divided equally between both set of batteries. The fire pumps shall be operated for a period of a least 10 minutes for each of the starts. Pressure settings that include automatic starting and stopping of the fire pump(s) shall be indicated on an etched plastic placard, attached to the corresponding pump controller.

#### 3.9.3.3 Alarms

All pump alarms, both local and remote, shall be tested.

#### 3.9.3.4 Miscellaneous

Valve tamper switches and flow indicators shall be tested. Pressure recorder operation relief valve settings, valve operations, operation and accuracy of gauges, and other accessory devices shall be verified.

#### 3.9.4 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, the Contractor shall performed corrective actions and repeat the tests. Tests shall be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

#### 3.9.5 Test Equipment

The Contractor shall provide all equipment and instruments necessary to conduct a complete final test, including 2.5 inch diameter hoses, playpipe nozzles, pitot tube gauges, portable digital tachometer, voltage and ampere meters, and calibrated oil-filled water pressure gauges. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during the test. The Government will furnish water for the tests.

#### 3.9.6 Test Documentation

The Manufacturer's Representative shall supply a copy of the manufacturer's certified curve for each fire pump at the time of the test. The Fire Protection Specialist shall record all test results and plot curve of each pump performance during the test. Complete pump acceptance test data of each fire pump shall be recorded. The pump acceptance test data shall be on forms that give the detail pump information such as that which is indicated in Figure A-11-2.6.3(f) of NFPA 20. All test data records shall be submitted in a three ring binder.

#### 3.9.7 As-Built Drawings

The Contractor shall submit As-Built Drawings, no later than 14 days after completion of the Final Tests. The Packaged Fire Pump with Enclosure Installation Drawings shall be updated to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

#### 3.10 DISINFECTION

After all system components are installed including pumps, piping, and other associated work, and all hydrostatic test(s) are successfully completed, thoroughly flush the pumps and all piping to be disinfected with potable water until there is no visible sign of dirt or other residue. and

hydrostatic test are successfully completed, each portion of the piping specified in this Section system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.11 FIELD TRAINING

The Fire Protection Specialist and the Manufacturer's Representative shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 2 hours of normal working time and shall start after the fire pump installation is functionally complete and after the Final Acceptance Test. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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## SECTION 13930A

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION  
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## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASTM INTERNATIONAL (ASTM)

ASTM A 135	(2001) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1998) Carbon Steel Track Bolts and Nuts
ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 1999e1) Ductile Iron Castings
ASTM A 795	(2000) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B 62	(2002) Composition Bronze or Ounce Metal Castings
ASTM B 75	(2002) Seamless Copper Tube
ASTM B 88	(2002) Seamless Copper Water Tube
ASTM D 2000	(2001) Rubber Products in Automotive Applications
ASTM F 436	(2002) Hardened Steel Washers

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1999) Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies
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## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1999) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for



## Ductile-Iron Pipe and Fittings for Water

AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C203	(2002; A C203a-99) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C651	(1999) Disinfecting Water Mains
AWWA C652	(1992) Disinfection of Water Storage Facilities
AWWA EWW	(1998) Standard Methods for the Examination of Water and Wastewater

## ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.11	(2002) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2002) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(1996) Square and Hex Bolts and Screws, Inch Series
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts (Inch Series)

## FM GLOBAL (FM)

FM P7825a (2003) Approval Guide Fire Protection

FM P7825b (2003) Approval Guide Electrical Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)MSS SP-71 (1997) Gray Iron Swing Check Valves,  
Flanged and Threaded Ends

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2000) Life Safety Code

NFPA 13 (1999) Installation of Sprinkler Systems

NFPA 1963 (1998) Fire Hose Connections

NFPA 24 (1995) Installation of Private Fire  
Service Mains and Their AppurtenancesNATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES  
(NICET)NICET 1014-7 (1995) Program Detail Manual for  
Certification in the Field of Fire  
Protection Engineering Technology (Field  
Code 003) Subfield of Automatic Sprinkler  
System Layout

## UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (1999) Building Materials Directory

UL Fire Prot Dir (2001) Fire Protection Equipment Directory

## 1.2 GENERAL REQUIREMENTS

Wet pipe sprinkler system shall be provided in all areas of the buildings. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. The Contractor shall design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

## 1.2.1 Hydraulic Design

The system shall be hydraulically designed to discharge a minimum density as indicated. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

#### 1.2.1.1 Hose Demand

An allowance for exterior hose streams as indicated on the drawings.

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply as indicated. Water supply shall be presumed available at the point of connection to existing main. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for PVC and copper tubing, and 140 for new cement-lined ductile-iron piping.

#### 1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. In buildings protected by automatic sprinklers, sprinklers shall provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, mechanical rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies. Exceptions are as follows:

1) Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

#### 1.3 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinkler shall be installed over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage.

#### 1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

#### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

#### Shop Drawings; G, AE

Three copies of the Sprinkler System Shop Drawings, no later than 21 days prior to the start of sprinkler system installation.

#### As-Built Drawings; G, RE

As-built shop drawings, at least 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

### SD-03 Product Data

#### Fire Protection Related Submittals; G, RE

A list of the Fire Protection Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist.

#### Sway Bracing; G, AE

For systems that are required to be protected against damage from earthquakes, load calculations shall be provided for sizing of sway bracing.

#### Materials and Equipment; G, AE

Manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided.

#### Hydraulic Calculations; G, AE

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

#### Spare Parts; G, RE

Spare parts data shall be included for each different item of material and equipment specified.

#### Preliminary Tests; G, RE

Proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests. Proposed date and time to begin the preliminary tests.

#### Final Acceptance Test; G, RE

Proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests. Proposed date and time to begin Final Acceptance Test, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material &

Test Certificates.

On-site Training; G, RE

Proposed On-site Training schedule, at least 14 days prior to the start of related training.

Fire Protection Specialist; G, RE

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations.

Sprinkler System Installer; G, RE

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

#### SD-06 Test Reports

Preliminary Test Report; G, RE

Three copies of the completed Preliminary Test Report, no later than 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

Final Acceptance Test Report; G, RE

Three copies of the completed Final Acceptance Tests Reports, no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.

#### SD-07 Certificates

Inspection by Fire Protection Specialist; G, RE

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports.

#### SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, RE

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified

wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour on-site response to a service call on an emergency basis.

#### 1.7 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

#### 1.8 FIRE PROTECTION SPECIALIST

Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.9 SPRINKLER SYSTEM INSTALLER

Work specified in this section shall be performed by the Sprinkler System Installer. The Sprinkler System Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.10 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes

advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

#### 1.11 SPARE PARTS

The Contractor shall submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

#### 1.12 SHOP DRAWINGS

The Sprinkler System Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

- a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.
- b. Floor plans drawn to a scale not less than  $1/8" = 1'-0"$  which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.
- c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.
- d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.
- e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially

duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

## 2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

## 2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b

## 2.4 UNDERGROUND PIPING COMPONENTS

### 2.4.1 Pipe

Piping from a point 6 inches above the floor to a point 5 feet outside the building wall shall be ductile iron with a rated working pressure of 150 psi conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feet outside the building walls shall comply with Section 02510A WATER DISTRIBUTION SYSTEM.

### 2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

## 2.5 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be steel or copper.

### 2.5.1 Steel Piping Components

#### 2.5.1.1 Steel Pipe

Except where indicated otherwise, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53/A 53M, or ASTM A 135. Pipe 2 inches and smaller shall be minimum Schedule 40 and pipe 2 1/2 inches and larger shall be minimum Schedule 10. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

#### 2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Steel press fittings shall be approved for fire protection systems. Galvanized fittings shall be used for piping systems or portions of piping systems utilizing galvanized piping. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel



gripping devices to bite into the pipe and segmented welded fittings shall not be used.

#### 2.5.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer; segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

#### 2.5.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

#### 2.5.1.5 Bolts, Nut, and Washers

Bolts shall be squarehead conforming to ASME B18.2.1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque. Nuts shall be hexagon type conforming to ASME B18.2.2. Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provided under all bolt heads and nuts.

### 2.5.2 Copper Tube Components

#### 2.5.2.1 Copper Tube

Copper tube shall conform to ASTM B 88, Types L and M.

#### 2.5.2.2 Copper Fittings and Joints

Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Grooved mechanical joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183.

### 2.5.3 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and of the type suitable for the application, construction, and pipe type and sized to be supported.

#### 2.5.4 Valves

##### 2.5.4.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

##### 2.5.4.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

#### 2.6 ALARM INITIATING AND SUPERVISORY DEVICES

##### 2.6.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 10 gpm or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

##### 2.6.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

#### 2.7 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

#### 2.8 WALL HYDRANT TEST CONNECTION

Wall hydrant shall be flush type with cast brass body, matching wall escutcheon lettered "Wall Hydrant" with a polished brass finish. The hydrant shall have two male outlets, caps and chains. Male outlets shall have 2 1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

#### 2.9 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be

used in accordance with their listed coverage limitations. Temperature classification shall be ordinary except that sprinklers in the elevator machine room and elevator pit shall have an intermediate temperature classification. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used.

#### 2.9.1 Concealed Sprinkler

Concealed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

#### 2.9.2 Recessed Sprinkler

Upright sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

#### 2.9.3 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, recessed, quick-response type with nominal 1/2 inch or 17/32 inch orifice. Pendent sprinklers shall have a polished chrome finish.

#### 2.9.4 Upright Sprinkler

Upright sprinkler shall be brass, quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

#### 2.9.5 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a brass finish. Sidewall sprinkler shall be the quick-response type.

### 2.10 DISINFECTING MATERIALS

#### 2.10.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

#### 2.10.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

### 2.11 ACCESSORIES

#### 2.11.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

#### 2.11.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

### 2.11.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

### 2.11.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located in mechanical rooms and as indicated.

### 2.11.5 Identification Sign

Valve identification sign shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

## 2.12 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 150 psi. The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

## PART 3 EXECUTION

### 3.1 FIRE PROTECTION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

### 3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.

### 3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance

with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

### 3.4 ABOVEGROUND PIPING INSTALLATION

#### 3.4.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible and rigid couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes.

#### 3.4.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

#### 3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

#### 3.4.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

##### 3.4.4.1 Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid and located along the axes of the ceiling tiles.

#### 3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

#### 3.4.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be

permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site.

Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.4.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

#### 3.4.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07840 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

#### 3.4.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

#### 3.4.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected at the riser zone control valve assemblies as a combination test and drain valve and located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with

the words "Inspector's Test.".

#### 3.4.11 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13.

#### 3.4.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

#### 3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

### 3.5 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 02510A WATER DISTRIBUTION SYSTEM.

### 3.6 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02300 EARTHWORK.

### 3.7 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 13851A FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE. All wiring for supervisory and alarm circuits shall be #14 AWG solid copper installed in metallic tubing or conduit. Wiring color code shall remain uniform throughout the system.

### 3.8 DISINFECTION

After all system components are installed and hydrostatic test(s) are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before

introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained. After successful completion, verify installation of all sprinklers and plugs and pressure test the system.

### 3.9 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 3.10 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

#### 3.10.1 Underground Piping

##### 3.10.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

##### 3.10.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.



### 3.10.2 Aboveground Piping

#### 3.10.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

#### 3.10.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor shall provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, and pitot tube gauge. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. A metal placard shall be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

#### 3.10.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

#### 3.10.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

### 3.11 FINAL ACCEPTANCE TEST

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. The Contractor shall submit the Final Acceptance Test Report as specified in the Submittals paragraph.

## 3.12 ON-SITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete but prior to the Preliminary Tests and Final Acceptance Test. The On-Site Training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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## SECTION 13945A

PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION  
**01/04**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1999) Liquid Chlorine
AWWA C651	(1999) Disinfecting Water Mains
AWWA C652	(2002) Disinfection of Water-Storage Facilities
AWWA EWW	(1998) Standard Methods for the Examination of Water and Wastewater

## ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.11	(2002) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(1996) Square and Hex Bolts and Screws, Inch Series
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts

## ASTM INTERNATIONAL (ASTM)

ASTM A 135	(2001) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(2003) Carbon Steel Track Bolts and Nuts
ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped,

	Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 1999e1) Ductile Iron Castings
ASTM A 795	(2000) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM F 436	(2003) Hardened Steel Washers
FM GLOBAL (FM)	
FM P7825a	(2003) Approval Guide Fire Protection
FM P7825b	(2003) Approval Guide Electrical Equipment
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE C62.41	(1991) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	
MSS SP-71	(1997) Gray Iron Swing Check Valves, Flanged and Threaded Ends
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 13	(2002) Installation of Sprinkler Systems
NFPA 24	(2002) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 70	(2002) National Electrical Code
NFPA 72	(2002) National Fire Alarm Code
NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)	
NICET 1014-7	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout
UNDERWRITERS LABORATORIES (UL)	
UL Bld Mat Dir	(2003) Building Materials Directory
UL Fire Prot Dir	(2003) Fire Protection Equipment Directory

## 1.2 GENERAL REQUIREMENTS

Preaction sprinkler system(s) shall be provided in areas indicated on the drawings. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall meet the requirements of NFPA 13 and NFPA 72. The sprinkler system shall be a

double interlocked system which admits water to sprinkler piping upon operation of both heat detection devices and automatic sprinklers. The Contractor shall design any portion of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping, and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. Pipe sizes which are not indicated on the drawings shall be determined by hydraulic calculations.

#### 1.2.1 Hydraulic Design

The system shall be hydraulically designed based on indicated densities and design areas. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

##### 1.2.1.1 Hose Demand

An allowance for exterior hose streams shall be as indicated.

##### 1.2.1.2 Basis for Calculations

The design of the system shall be based on the indicated water supply. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for galvanized steel piping, 140 for new cement-lined ductile-iron piping.

#### 1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 100 square feet for extra hazard occupancies, 130 square feet for ordinary hazard occupancies, and 225 square feet for light hazard occupancies.

#### 1.2.3 Control System

The control system shall meet the requirements of NFPA 72. The control panel shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b for "Releasing Device Service". The control panel and the solenoid valve that activates the water control valves shall be compatible with each other. Compatibility shall be per specific UL listing or FM approval of the control equipment.

##### 1.2.3.1 Power Supply

The primary operating power shall be provided from two single-phase 120 VAC circuits. Transfer from normal to backup power and restoration from backup to normal power shall be fully automatic and shall not initiate a false alarm. Loss of primary power shall not prevent actuation of the respective automatic water control valve upon activation of any alarm initiating device. Backup power shall be provided through use of rechargeable, sealed, lead calcium storage batteries.

##### 1.2.3.2 Circuit Requirements

Alarm initiating devices shall be connected to initiating device circuits (IDC), Style D, in accordance with NFPA 72. Alarm notification or indicating appliances shall be connected to indicating appliance circuit (IAC), Style W in accordance with NFPA 72. A separate circuit shall be provided for actuation of each individual automatic water control valve.



The circuits that actuate the water control valves shall be fully supervised so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors shall be indicated at the control panel.

### 1.3 SYSTEM OPERATIONAL FEATURES

The system shall include a heat detection system, manual actuation stations, supervisory and alarm switches, alarm notification appliances, control panel and associated equipment. Preaction sprinkler system piping shall be provided with supervisory air pressure not to exceed 30 psig.

#### 1.3.1 System Actuation

Activation of any single heat detector or a single manual actuation station shall actuate alarm zone circuits of the control panel that, in turn, shall actuate the corresponding automatic water control valve. Actuation of the automatic water control valve shall cause water to fill the preaction system piping and be discharged from fused sprinklers.

#### 1.3.2 Alarm Functions

Activation of any heat detector or sprinkler pressure alarm switch or manual actuation station shall cause the illumination of the respective zone annunciator, and activation of the building fire alarm system. Valve tamper alarm shall be monitored by the system control panel and transmitted to the building fire alarm system as a trouble alarm.

#### 1.3.3 Supervisory Functions

The reduction of supervisory air pressure within the sprinkler system piping to less than 10 psi or the occurrence of a single open or a single ground fault in any alarm initiating device circuit, in the automatic water control valve actuation circuit, in any alarm indicating appliance circuit or in other electrically supervised circuit shall cause the individually labeled control panel trouble light to be illuminated, the audible trouble alarm to be activated, and a trouble alarm to be transmitted to the building fire alarm control panel.

### 1.4 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinkler shall be installed over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage.

### 1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

### 1.6 FIELD MEASUREMENTS

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.7 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Shop Drawings; G, AE

Three copies of the Sprinkler System Drawings, no later than 21 days prior to the start of sprinkler system installation. The Sprinkler System Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than  $1/8" = 1'-0"$  which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

f. Complete point-to-point wiring diagram of the detection and control system. Indicate the detailed interconnection of control panel modules to the devices, the number and size of conductors in each conduit, and size of conduit. Connection points shall be indicated and coordinated with the terminal identification marked on the devices. Complete internal wiring schematic of the control panel and each electrical device shall be provided. Detailed description of the functions of the control panel and each module

shall be provided.

#### As-Built Drawings

As-built drawings, at least 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

#### SD-03 Product Data

##### Fire Protection Specialist; G, RE

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system shop drawings and hydraulic calculations.

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system shop drawings and hydraulic calculations.

##### Sprinkler System Installer Qualifications

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

##### Fire Protection Related Submittals

A list of the Fire Protection Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist.

##### Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations for sizing of sway bracing.

##### Materials and Equipment; G, AE

Manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided.

##### Hydraulic Calculations; G, AE

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

##### Storage Batteries; G, RE

Calculations to substantiate the total requirements for supervisory and alarm power. Ampere-hour requirements for each system component and each control panel component or module, under both normal and alarm conditions shall be included. The battery recharging period shall be included with the calculations.

#### Spare Parts

Spare parts data for each different item of material and equipment specified.

#### Preliminary Tests; G, RE

Proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests.

Proposed date and time to begin Preliminary Tests, submitted with the Preliminary Tests Procedures.

#### Final Acceptance Tests; G, RE

Proposed procedures for Final Acceptance Tests, no later than 14 days prior to the proposed start of the tests.

Proposed date and time to begin Final Acceptance Tests, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

#### On-Site Training; G, RE

Proposed On-site Training schedule, at least 14 days prior to the start of related training.

### SD-06 Test Reports

#### Preliminary Tests; G, RE

Three copies of the completed Preliminary Tests Reports, no later than 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

#### Final Acceptance Tests; G, RE

Three copies of the completed Final Acceptance Tests Reports, no later than 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.

### SD-07 Certificates

Inspection by Fire Protection Specialist; G, RE

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary, Detection and Control Systems, and Final Acceptance Test Reports.

#### SD-10 Operation and Maintenance Data

##### Operating and Maintenance Instructions; G, RE

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

#### 1.8 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

#### 1.9 FIRE PROTECTION SPECIALIST

Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system

specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.10 SPRINKLER SYSTEM INSTALLER QUALIFICATIONS

Work specified in this section shall be performed by the Sprinkler System Installer. The Sprinkler System Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.11 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

#### 1.12 SPARE PARTS

The Contractor shall submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

#### 2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

## 2.4 ABOVEGROUND PIPING COMPONENTS

### 2.4.1 Steel Pipe

Except as modified herein, steel pipe shall be galvanized conforming to the applicable requirements of NFPA 13, and ASTM A 795, ASTM A 53/A 53M, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

### 2.4.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be galvanized steel conforming to ASME B16.9 or ASME B16.11. Fittings that sprinklers, drop nipples or riser nipples (sprigs) are screwed into shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

### 2.4.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer; segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

### 2.4.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

#### 2.4.4.1 Bolts

Bolts shall be squarehead conforming to ASME B18.2.1. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

#### 2.4.4.2 Nuts

Nuts shall be hexagon type conforming to ASME B18.2.2.

#### 2.4.4.3 Washers

Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provided under all bolt heads and nuts.

### 2.4.5 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and of the type suitable for the application, construction, and pipe type and size to be supported.

#### 2.4.6 Valves

##### 2.4.6.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

##### 2.4.6.2 Check Valves

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

#### 2.5 AUTOMATIC WATER CONTROL VALVE

Automatic water control valve shall be electrically-actuated and rated for a working pressure of 175 psi. Valve shall be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve shall be an integral component of the valve or shall be approved for use by the water control valve manufacturer. Solenoid valve shall be rated at 24 volts direct current, and shall be normally closed type that operates when energized. Solenoid valves shall be rated for a maximum pressure differential of 175 psi. Water control valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly shall be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Each assembly shall include an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device shall be a standard accessory component of the valve manufacturer and shall be labeled as to its function and method of operation. Valves located in hazardous locations shall be approved for the hazard classification of the area where located.

#### 2.6 SUPERVISORY AIR SYSTEM

##### 2.6.1 Air Compressor

Air compressor shall be 120 volt single stage oil less type, air cooled, electric-motor driven, equipped with a check valve, centrifugal pressure and moisture unloader, pressure switch for automatic starting and stopping. Pressure switch shall be set to start the compressor at 20 psi and stop it at 30 psi. A safety relief valve, set to operate at 65 psi, shall be provided. The compressor shall be sized to pressurize the system to 30 psi within 30 minutes.

##### 2.6.2 Air Pressure Maintenance Device

Device shall be a pressure regulator that automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16 inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing maximum inlet pressure of 100 psi to a fixed outlet pressure adjustable to 10 psi.



### 2.6.3 Air Supply Piping System

Each preaction system shall be equipped with a separate pressure maintenance device, shutoff valve, bypass valve and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A 795 or ASTM A 53/A 53M.

Use a 24-inch (minimum) length of non-metallic pipe at point of penetration of SCIF barrier (wall or floor).

### 2.6.4 Low Air Pressure Switch

Each preaction system shall be provided with an air pressure switch connected to the control panel. Upon reduction of supervisory air pressure to approximately 10 psi, the low air pressure switch shall actuate the audible alarm device and a red low-air alarm light on the control panel annunciator.

## 2.7 SPRINKLERS

Sprinklers for preaction system shall be automatic, fusible solder or glass bulb type; sprinklers for deluge systems shall be open type without the fusible element. Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be ordinary. Extended coverage sprinklers shall not be used.

### 2.7.1 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, recessed quick-response type with nominal 1/2 inch orifice. Pendent sprinklers shall have a polished chrome finish.

### 2.7.2 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 1/2 inch orifice.

## 2.8 DISINFECTING MATERIALS

### 2.8.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

### 2.8.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

## 2.9 ACCESSORIES

### 2.9.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

### 2.9.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

### 2.9.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

### 2.9.4 Identification Sign

Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

## 2.10 CONTROL PANEL - PSCP

Panel shall be UL listed or FM approved for "Releasing Device Service" or shall have modules approved for this purpose. Panel shall contain all components and equipment required to provide the specified operational and supervisory functions of the system. Components shall be housed in a flush-mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the working condition and accuracy of the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

### 2.10.1 Zone Annunciator

A separate alarm and trouble lamp shall be provided for each active and spare zone and shall be located on exterior of cabinet door or be visible through the cabinet door. A minimum of two spare alarm zones that are fully operational shall be provided. Each lamp shall provide specific identification of the zone by means of a permanently attached rigid plastic or metal sign with either raised or engraved letters. Zone identification shall consist of a unique zone number as well as a word description of the zone.

### 2.10.2 System Zoning

The system shall be zoned as follows:

ZONE NO.	DESCRIPTION
1.	Manual Actuation
2.	Heat Detector
3.	Sprinkler Pressure Alarm Switch
4.	Low Air Pressure
5.	Tamper Switch

#### 2.10.3 Primary Power Supply

Primary power and trouble alarm power to the Control Panel shall be supplied from two 120 VAC circuits. Power to the control panel shall be as indicated. Panel shall be permanently marked "PREACTION SPRINKLER SYSTEM".

#### 2.10.4 Emergency Power Supply

Emergency power shall be provided for system operation in the event of failure of the primary power supply and shall consist of rechargeable storage battery system. Transfer from normal to emergency power or restoration from emergency to normal power shall be automatic and shall not cause transmission of a false alarm.

##### 2.10.4.1 Storage Batteries

Storage Batteries shall be sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the system for a period of 4 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all alarm indicating devices in the alarm mode for a minimum period of 15 minutes. Battery cabinet shall be a separate compartment at the bottom of the control panel. The battery cabinet shall have adequate space for spare duplicate storage batteries. Batteries shall be mounted on a noncorrosive and nonconductive base or pad.

##### 2.10.4.2 Battery Charger

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours using the high charging rate. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly. The charger shall be located in control panel cabinet.

#### 2.11 ALARM INITIATING DEVICES

##### 2.11.1 Heat Detectors

Detectors located in areas subject to moisture, exterior atmospheric conditions or hazardous locations as defined in NFPA 70 shall be approved for such locations. Detectors shall be listed or approved for 50 foot spacing between detectors. The detector shall be equipped with an alarm indicating light in its base that lights when the detector is in an alarm condition. Two spare detectors of each type and temperature rating shall be provided.

#### 2.11.1.1 Rate Compensation Detector

Detector shall be of the spot type with a temperature classification rating of ordinary as defined by NFPA 72. Detectors listed or approved as "rate anticipation" type will be accepted. Detector shall automatically reset when temperature drops below detector temperature rating. Detector shall be hermetically sealed.

#### 2.11.2 Manual Actuation Station

Station shall be mounted at 42 inches above the floor, unless otherwise shown. Station shall be arranged to activate the deluge system. Station shall be dual-action type requiring two separate operations in order to cause system discharge. Station shall be colored lime yellow. Station shall be provided with a positive visible indication of operation of the station. Station shall be weatherproof type and shall be provided with an engraved label indicating PREACTION SPRINKLER SYSTEM.

#### 2.11.3 Sprinkler Pressure Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches. The switch shall have a service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

#### 2.11.4 Waterflow Alarm

Shall be connected to the Fire Alarm Control Panel (FACP) in accordance with Section 13851A FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE.

#### 2.11.5 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

### 2.12 NOTIFICATION APPLIANCES

Notification appliances shall be suitable for connection to supervised alarm indicating circuits. Appliance shall have a separate screw terminal for each conductor. The surface of the appliance shall be red in color.

#### 2.12.1 Alarm Bell

Bell shall be 10 inch diameter, surface-mounted vibrating type with matching back box. Sound output shall be a minimum of 85 DBA at 10 feet. Bell shall operate on nominal 24 VDC. Bells shall have screw terminals for in-out wiring connection. Bells used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

### 2.13 WIRING

Wiring for alternating current (AC) circuits shall be 12 AWG minimum. Wiring for low voltage direct current (DC) circuits shall be No. 14 AWG minimum. Power wiring (over 28 volts) and control wiring shall be isolated. Wiring shall conform to NFPA 70. System field wiring shall be

solid copper and installed in electrical metallic tubing or in metallic conduit, except rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same function shall be similarly color coded. Wiring color code shall remain uniform throughout the circuit. Pigtail or T-tap connections to alarm initiating, alarm indicating, supervisory, and actuation circuits are prohibited.

### PART 3 EXECUTION

#### 3.1 FIRE PROTECTION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

#### 3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of publications referenced herein.

#### 3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

#### 3.4 ABOVEGROUND PIPING INSTALLATION

##### 3.4.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible and rigid couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes.

##### 3.4.2 Piping in Exposed Areas

Exposed piping shall be installed so as not diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

##### 3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

#### 3.4.4 Pendent Sprinklers Locations

Sprinklers installed in the pendent position shall be of the listed dry pendent type, unless otherwise indicated. Dry pendent sprinklers shall be of the required length to permit the sprinkler to be threaded directly into a branch line tee. Hangers shall be provided on arm-overs exceeding 12 inches in length. Dry pendent sprinkler assemblies shall be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space. Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid and located along the axes of the ceiling tiles. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

#### 3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

#### 3.4.6 Pendent Sprinklers Locations

Sprinklers installed in the pendent position shall be of the listed dry pendent type, unless otherwise indicated. Dry pendent sprinklers shall be of the required length to permit the sprinkler to be threaded directly into a branch line tee. Hangers shall be provided on arm-overs exceeding 12 inches in length. Dry pendent sprinkler assemblies shall be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space. Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid and located along the axes of the ceiling tiles. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

#### 3.4.7 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site.

Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.4.8 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets

of a cross, or where the reduction in size is less than 1/2 inch.

#### 3.4.9 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07840 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

#### 3.4.10 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

#### 3.4.11 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected at the riser as a combination test and drain valve; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

#### 3.4.12 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 3 gallons, the auxiliary drain shall consist of a valve not smaller than 1/2 inch and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 3 gallons, the auxiliary drain shall consist of two 1 inch valves and one 2 x 12 inch condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 1 inch in diameter. Tie-in drain lines shall be pitched a minimum of 1/2 inch per 10 feet.

#### 3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

### 3.5 ELECTRICAL WORK

Unless otherwise specified herein, power supply equipment and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR.

#### 3.5.1 Overcurrent and Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. Cables and conductors that serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

#### 3.5.2 Grounding

Grounding shall be provided to building ground.

#### 3.5.3 Wiring

System field wiring shall be installed in 3/4 inch minimum diameter electrical metallic tubing or metallic conduit. Wiring for the sprinkler system fire detection and control system shall be installed in tubing or conduits dedicated for that use only and not installed in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked and labeled in accordance with the wiring diagram. No more than one conductor shall be installed under any screw terminal.

Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is not permitted. Wiring within any control equipment shall be readily accessible without removing any component parts.

Conductors shall be color-coded and shall be identified within each enclosure where a connection or termination is made. Conductor identification shall be by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Circuits shall be wired to maintain electrical supervision so that removal of any single wire from any device shall cause a "trouble" condition on the control panel.

#### 3.5.4 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 24 inches and not more than 78 inches above the finished floor.

#### 3.5.5 Detectors

Detectors shall be ceiling-mounted per NFPA 72 and shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location.

#### 3.5.6 Manual Actuation Stations

Manual actuation stations shall be mounted readily accessible and 42 inches above the finished floor.



### 3.5.7 Notification Appliances

Notification appliances shall be mounted a minimum of 8 feet above the finished floor unless limited by ceiling height.

### 3.6 DISINFECTION

After all system components are installed and hydrostatic test(s) are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained. After the successful completion, all sprinklers or plugs and gravity flush all drops or trapped piping.

### 3.7 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 3.8 PRELIMINARY TESTS

The system including the aboveground piping, detectors and control system and system components shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

#### 3.8.1 Aboveground Piping

##### 3.8.1.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA

13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

#### 3.8.1.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 50 psi shall be conducted for 24 hours. There shall be no drop in gauge pressure in excess of 1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

#### 3.8.2 Automatic Water Control Valve Test

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector and a manual actuation station connected to the control panel and a manual actuation device that is part of the valve trim. A full-flow main drain test shall be made. For preaction systems with supervisory air, the air pressure shall be reduced to verify proper operation of the air supply system and associated supervisory alarm devices.

#### 3.9 FINAL ACCEPTANCE TESTS

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Each system shall be completely drained after each trip test. The system air supply system shall be tested to verify that system pressure is restored in the specified time. In addition, the Fire Protection Specialist shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. After the system has been tested and drained, the system shall be drained periodically for at least 2 weeks until it can be assured that water from the system has been removed.

##### 3.9.1 Control System Test

Testing shall be in accordance with NFPA 72. The test shall include the following:

- a. Visual inspection of wiring connections.
- b. Opening the circuit at each alarm initiating device, solenoid valve, and notification appliance to test the wiring and supervisory features.
- c. Test of each function of the control panel.
- d. Test of each circuit in the normal, open and ground fault modes.

- e. Test of each initiating device in both normal and trouble conditions.
- f. Test of each control circuit and device.
- g. Test of each alarm notification appliance.
- h. Test of the battery charger and batteries.
- i. Operational tests under emergency power supply, including activation of connected alarm notification appliances for the specified time period.

#### 3.9.2 Trip-tests of Automatic Water Control Valves

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control panel and the manual release which is part of the valve trim. Each valve shall be returned to normal condition after each test. Control valves on preaction systems shall remain open until piping is filled with water.

#### 3.9.3 Tests of Supervisory Air System

Preaction system supervisory air pressure shall be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Air pressure shall be restored to verify trouble signal restoration. Automatic start/stop features of air compressor shall be tested.

#### 3.10 ON-SITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. The On-Site Training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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## HYDRAULIC ELEVATORS

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## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASME INTERNATIONAL (ASME)

- |              |  |
|--------------|--|
| ASME A17.1   | (2002) Safety Code for Elevators and Escalators        |
| ASME A17.2.2 | (1997) Inspector's Manual for Hydraulic Elevators      |
| ASME B16.9   | (2001) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11  | (2001) Forged Fittings, Socket-Welding and Threaded    |

## ASTM INTERNATIONAL (ASTM)

- |                 |  |
|-----------------|--|
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 106      | (1999e1) Seamless Carbon Steel Pipe for High-Temperature Service           |
| ASTM D 92       | (2001) Flash and Fire Points by Cleveland Open Cup                         |
| ASTM D 97       | (1996a) Pour Point of Petroleum Products                                   |

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

- |             |  |
|-------------|--|
| 36 CFR 1191 | (1998) ADA Accessibility Guidelines for - Buildings and Facilities |
|-------------|--|

## AMERICAN WELDING SOCIETY (AWS)

- |                |  |
|----------------|--|
| AWS D1.1/D1.1M | (2000) Structural Welding Code - Steel |
|----------------|--|

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- |           |                              |
|-----------|------------------------------|
| NEMA MG 1 | (1998) Motors and Generators |
|-----------|------------------------------|

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2002) National Electrical Code

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Detail Drawings; G, RE

Detail drawings including dimensioned layouts in plan and elevation showing the arrangement of elevator equipment, accessories, supporting systems, anchorage of equipment, clearances for maintenance and operation; and details on hoistway, doors and frames, operation and signal stations, controllers, motors, guide rails and brackets, cylinder and plunge unit, and points of interface with normal power fire alarm system. Drawings shall show any revised building electrical system required to make supplied elevator system function as specified. Drawings shall contain complete wiring diagrams showing electrical connections and other details required to demonstrate sequence of operations and functions of system devices. Drawings shall include the appropriate sizing of electrical protective devices which are frequently different from National Electrical Code standard sizes.

Submit one set of wiring diagrams in plastic or glass cover, framed and mounted in elevator machine room. Deliver other sets to Contracting Officer. Coded diagrams are not acceptable unless adequately identified.

## SD-03 Product Data

## Passenger Elevators; G, RE

Include information on motor, pump, gages, piston and cylinder, piping and valves, hall station, and buffer on elevators and accessories. For elevator supporting systems, include information on car control systems. On data sheets, provide document identification number or bulletin number, published or copyrighted prior to the date of contract bid opening.

## Field Quality Control; G, RE

A plan detailing the testing procedures shall be submitted 60 days prior to performing the elevator tests.

## Logic Control; G, RE

Microprocessor control system, including appropriate hardware and software and other specified requirements.

## SD-05 Design Data



#### Reaction Loads; G, RE

Calculations of reaction loads imposed on building by elevator system that comply with ASME A17.1. Calculations shall be certified by a Registered Professional Engineer. Do not fabricate materials nor perform construction until approved by Contracting Officer.

#### Heat Loads; G, RE

Calculations for total anticipated heat loads generated by all the elevator machine room equipment. Calculations shall be certified by a Registered Professional Engineer. Do not fabricate materials nor perform construction until approved by the Contracting Officer.

### SD-06 Test Reports

#### Field Tests Reports

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of installed system shall be submitted 14 days after the successful completion of testing.

### SD-07 Certificates

#### Qualifications

A letter no later than 14 days after the Notice to Proceed providing the name and Statement of Qualifications, including ASME A17.1 Certificate and all required state and local licenses of the individual who will perform the duties specified herein for the Elevator Inspector. A letter of endorsement from the elevator manufacturer certifying that the Elevator Specialist is acceptable to manufacturer no later than 14 days after the Notice to Proceed providing the name and Statement of Qualifications of the individual who will perform the duties specified herein for the Elevator Specialist. Copies of certified welders' qualifications, demonstrating compliance with AWS D1.1/D1.1M, Section 5; list welders' names with corresponding code marks.

### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RE  
Maintenance and Diagnostic Tools; G, RE  
Maintenance and Repair Action Plan; G, RE

Submit data package in accordance with Section 01781 OPERATION AND MAINTENANCE DATA. Three Operation and Maintenance Manuals, submitted 28 days prior to the Operation and Maintenance Training. Include a list of phone numbers, personnel contacts, and all tools required for operation and maintenance.

Operation and Maintenance Training; G, RE

Proposed Onsite Training schedule, submitted concurrently with the

## Operation and Maintenance Manuals.

### 1.3 ELEVATOR SYSTEM

Provide pre-engineered elevator system by manufacturer regularly engaged in the manufacture of elevator systems and that complies with ASME A17.1 in its entirety, ASME A17.2.2 in its entirety, and additional requirements specified herein. The Contractor shall submit: 1) Detail Drawings as required in the Submittals paragraph; 2) calculations for the Reaction Loads imposed on the building by and 3) Heat Loads generated by the elevator system.

### 1.4 QUALIFICATIONS

#### 1.4.1 Elevator Specialist

Work specified in this section shall be performed under the direct guidance of the Elevator Specialist. The Elevator Specialist shall be regularly engaged in the installation and maintenance of the type and complexity of elevator system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 24 months. Elevator system manufacturer shall provide letter of endorsement from the elevator manufacturer certifying that the Elevator Specialist is acceptable to manufacturer. The Elevator Specialist shall oversee the acceptance inspections and tests, and shall sign and certify the successful results. The Elevator Specialist, after completion of the acceptance inspections and tests, shall certify in writing that the installation is in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

#### 1.4.2 Elevator Inspector

1) The Elevator Inspector shall be certified in accordance with the requirements of ASME A17.1. The Certified Elevator Inspector shall inspect the installation of the elevator(s) to assure that the installation conforms with all contract requirements. The Elevator Inspector shall be directly employed by the Prime Contractor and be independent of the Elevator System Manufacturer and the Elevator Specialist and shall witness the acceptance inspections and tests, shall approve all results and shall sign and certify the successful results. The Elevator Inspector, after completion of the acceptance inspections and tests, shall certify in writing that the installation is accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

#### 1.4.3 Welders' Qualifications

Comply with AWS D1.1/D1.1M, Part 4 Qualifications. Provide certified copies of welders' qualifications. List welders' names with corresponding code marks to identify each welder's work.

### 1.5 NEW INSTALLATION SERVICE

Provide routine warranty service in accord with manufacturer's warranty requirements, for period of 12 months after date of acceptance by Contracting Officer. Perform work during regular working hours. Include

24-hour emergency service, with 1 hour response time, during this period without additional cost to Government. Include adjustments, greasing, oiling, and cleaning. Provide routine inspection and tests of elevators in accordance with ASME A17.1 Section 8.11.3 and ASME A17.2.2. Provide supplies and parts to keep elevator system in operation. Perform service only by factory trained personnel.

#### 1.5.1 Special Operations

Every month, test Firefighters' Service in accordance with ASME A17.1, Section 8.6.10.1. Schedule to not interfere with building operations. Provide written results of test operation to the Contracting Officer.

#### 1.5.2 Documentation

Document all inspection and testing. Maintain copy of documentation in machine room.

#### 1.5.3 Maintenance and Diagnostic Tools

Provide all special tools and software necessary to service and maintain elevator; deliver at time of final acceptance. Provide one of each tool. Include solid state or microprocessor diagnostic tools if unavailable on the open market. Provide necessary diagnostic software where the solid state or microprocessor diagnostic tools are available on the open market

#### 1.5.4 Keys for Elevator Key Switches

Provide minimum of twelve keys per unique cylinder used on all key switches for single elevator. Keys shall be provided with brass or fiberglass tags marked 'PROPERTY OF THE U. S. GOVERNMENT' on one side with function of key or approved code number on other side.

### 1.6 FIRE PROTECTION SYSTEM

Fire protection system shall be in accordance with Section 13851A FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE - BATTALION HEADQUARTERS. Additional fire protection requirements found in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION will apply as directed by the Contracting Officer.

### 1.7 MAINTENANCE AND REPAIR ACTION PLAN

Provide plan of action prepared by the Elevator Specialist to provide emergency and routine maintenance in accordance with paragraph titled NEW INSTALLATION SERVICE. Provide a list of phone numbers, personnel contacts, and all tools to the Contracting Officer.

## PART 2 PRODUCTS

### 2.1 PASSENGER ELEVATORS

#### 2.1.1 Basic Requirements

- a. Rated Load: 3500 lbs.
- b. Rated Speed: 100 fpm
- c. Travel Length: 14 ft., 8 inches

- d. Number of Stops: 2
- e. Number of Hoist Way Openings: 2 Front
- f. Car Inside Dimensions: 6 ft. 8-in. wide, 5 ft. 5-in. deep and 8 ft. 0-in. high
- g. Car Door Opening: 3 ft. 6-in. wide and 7 ft. 0-in. high
- h. Car Door Types: Single-speed side slide.

#### 2.1.2 Cab Enclosures and Door Finishes

Provide finishes as listed below:

- a. Floor; vinyl composition tile.
- b. Walls; laminated plastic on particleboard. Provide each cab wall with equally spaced and equally sized wall panels. All fasteners shall be concealed.  
Wall trim; stainless steel.  
Accessories; hand rails.
- c. Interior face of door(s); stainless steel.
- d. Ceilings; eggcrate.  
Ceiling frame; anodized aluminum.
- e. Hoistway Doors and Frame Finishes  
Provide finishes on exterior of hoistway as follows:
  - (1) Frame; prefinished steel.
  - (2) Exterior face of door; prefinished steel.

#### 2.2 SPECIAL OPERATION AND CONTROL

Provide all special operations and control systems in accordance with ASME A17.1. Provide special operation key switches with 6 pin cylinder locks with removable cores. Provide a key control lock for each operation system.

##### 2.2.1 Firefighters' Service

Provide equipment and signaling devices. The designated level for Firefighters' key operated switch is the ground floor.

##### 2.2.2 Smoke Detectors

Smoke detectors are specified in Section 13851A FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE - BATTALION HEADQUARTERS, including conduit and wiring from each detector to elevator machinery space control panel. Provide connections directly to elevator controls which will, when smoke is detected by any smoke detector, actuate Firefighters' Service and send each elevator to the correct floor as required by ASME A17.1. Provide dual-contact smoke detectors located in the elevator lobbies and the elevator machine room. Provide dual-contact smoke detector at top of hoistway. The circuit for elevator controller actuation of Firefighters' Service shall include only these smoke detectors. In lieu of dual-contact smoke detectors, an addressable fire alarm system with listed smoke detectors can be used in the above stated locations. Ensure that all smoke

detectors are mounted on finished ceiling.

### 2.2.3 Fire Sprinklers

Provide fire sprinklers in accordance with Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION; providing dual contact flow switch, check valve, and shutoff valve in each sprinkler line immediately outside of each machine room and hoistway. Provide electrical connection to fire sprinkler system in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. For each elevator, provide control wiring connecting the flow switch to the shunt trip equipped circuit breaker within the electrical panel serving the main line disconnect. Upon flow of water, flow switch shall instantaneously send a signal to cause opening of shunt-trip equipped mainline circuit breaker, in compliance with ASME A17.1, Section 2.8.2, and send a signal to fire alarm control panel to indicate water flow condition.

Machine room sprinkler flow switch actuation shall shunt trip all elevator(s) served by the machine room. Hoistway sprinkler flow switch actuation shall shunt trip all elevator(s) in the hoistway.

### 2.2.4 Top-of-Car Operating Device

Provide operating device mounted on or from car crosshead, to permit operation of car at 150 fpm maximum for adjustment, maintenance, testing, and repair. Include integral or remote safety device, continuous pressure "UP" and "DOWN" switches or buttons, emergency stop switch, and inspection switch.

### 2.2.5 Hoistway Access Switches

Provide key-operated hoistway access switch to permit limited movement of car at terminal floors for car positioning, operative only when "INSPECTION" switch in car operating panel is in the "INSPECTION" position.

Locate switch 6 feet above floor level, within 12 inches of hoistway entrance frame or with only ferrule exposed when located in entrance frame.

### 2.2.6 Independent Service

Provide exposed key-operated switch in car operating panel to enable independent service and simultaneously disable in-car signals and landing-call responses. Provide indicator lights that automatically illuminate during independent service.

### 2.2.7 Elevator Operation

#### 2.2.7.1 Single, Two-Stop, Automatic Operation

Provide Single Two-Stop Automatic Operation. Provide illuminating push buttons.

## 2.3 ELEVATOR DRIVE SYSTEM

Provide hydraulic pump unit, piping, cylinder/plunger assembly, and rated equipment in accordance with ASME A17.1, which will operate at a maximum working pressure of less than 400 psig.

### 2.3.1 Hydraulic Pump Unit

Provide self-contained unit including oil-hydraulic elevator pump, electric motor, drive assembly, oil strainer in suction line, structural steel outer

base with tank and supports, oil-tight drip pan, and inner pump-mounting base. Limit acoustic output of elevator machine to 80 dbA. Provide sound-insulating panels to isolate airborne noise from non oil-immersed pump-motor assembly. Provide ventilation to cool hydraulic pump unit. Finish ferrous surfaces with rust-inhibiting paint.

#### 2.3.1.1 Tank Capacity

Provide tank capacity for full plunger displacement plus at least 10 gallons.

#### 2.3.2 Hydraulic Controls and Equipment

Provide electrically operated "UP" valve, constant velocity "DOWN" valve, "UP" and "DOWN" leveling valves, "BYPASS UPON STARTING" valve, check valve, vacuum relief valve, automatic shutoff (rupture) valve, safety relief valve, manually operated lowering valve, and scavenger pump unit.

##### 2.3.2.1 Manual Shutoff Valves

Provide 1/4 turn ball valve rated at 300 psi at elevator hydraulic pump suction inlet if pump is mounted outside the oil reservoir and the suction line exits the reservoir below the maximum oil level in the reservoir. Provide 1/4 turn ball valve rated at 600 psi at elevator pump discharge line in the machine room and in the oil supply line next to and on the pump side of the automatic shutoff valve in the pit.

##### 2.3.2.2 Manual Lowering Valve

Limit car descending speed under manual operation to 20 fpm. Provide rigid plastic red tag for valve identification, inscribed "MANUAL LOWERING VALVE."

##### 2.3.2.3 Pump Discharge Strainer

Provide strainer in pump discharge to prevent foreign materials from entering control system and cylinder-plunger unit (jack).

##### 2.3.2.4 Muffler

Provide blowout-proof muffler, containing pulsation-absorbing materials in oil line between pump unit and jack.

##### 2.3.2.5 Pressure Switch

Where cylinders are installed with top of cylinder above top of oil reservoir, provide pressure switch in oil line between cylinder and electric lowering valve(s) to prevent operation of lowering valve(s) unless positive pressure exists at top of cylinder.

##### 2.3.2.6 Scavenger Pump Unit

Provide a scavenge oil reservoir, an electrically operated oil transfer pump, scavenge oil lines, a strainer, and pump controls. Connect the scavenge oil reservoir to the elevator cylinder between the plunger packing area and the plunger drip (wiper) ring, to capture the oil leaking by the plunger pressure packing. Provide a vacuum relief valve. Connect the scavenge oil pump suction to the scavenge oil reservoir and the strainer, and the discharge to the elevator oil reservoir. Provide a scavenge oil reservoir level switch to control the scavenge oil pump. Scavenger pump shall operate independently of elevator hydraulic fluid pressure. Provide

a manual-reset pit flood switch to prevent pump operation if pit is flooded. Anchor pump and oil reservoir to the pit floor.

#### 2.3.2.7 Piping and Accessories

Provide ASTM A 53/A 53M or ASTM A 106, Schedule 80, black steel piping with ASME B16.9 and ASME B16.11 fittings. Schedule 80 piping shall extend from the pump control valve body, inside the pump unit, to the hydraulic cylinder in the hoistway. Provide dielectric union at each end of the "pump to cylinder" oil supply line. Provide hangers or supports for all piping. Provide welded or threaded forged pipe fittings that are located between the shut off valve and the cylinder inlet.

#### 2.3.2.8 Low Oil Condition

Provide device for elevator to protect pumping equipment in event oil level is too low. When device operates, it shall stop pump and motor and cause car to descend to lowest landing, open car doors and cease elevator operation except for door control circuits. Provide illuminating indicator on machine room control panel to alert upon a low oil condition.

#### 2.3.2.9 Oil Characteristics

- a. Viscosity, Saybolt Universal Seconds 145 to 160 at 100 degrees F.
- b. Viscosity, Saybolt Universal Seconds 42 to 44 at 210 degrees F.
- c. Pour Point, ASTM D 97, -15 degrees F maximum.
- d. American Petroleum Institute (API) Gravity 29 to 33 at 60 degrees F.
- e. Flash Point, ASTM D 92, 375 degrees F minimum.

#### 2.3.2.10 Oil Temperature Device

Provide means to maintain oil temperature between 60 and 100 degrees F regardless of ambient temperature.

#### 2.3.3 Cylinder-Plunger Unit

Provide a direct plunger type hydraulic elevator. Provide a plunger of single-piece seamless steel construction. Provide stop plate or ring welded to bottom of the plunger. Provide packing and wiper (drip) ring with outlet for connection to the scavenge oil reservoir to collect leakage oil from cylinder for either inspecting for contamination or returning to tank. Use only standard packing glands with bolts that compress packing. Provide threaded 1/4 inch bleeder valve at top of cylinder just below packing gland. Telescopic cylinder-plunger units are not acceptable.

#### 2.3.4 Cylinder Protection

Protect the cylinder with a pipe-manufacturer applied "Applied Extruded Coating." The AEC coating application process shall include the following steps as a minimum: blast clean the bare pipe exterior surfaces to white metal, apply a minimum of 0.010 inch undercoating of heated butyl rubber adhesive; and apply a minimum of 0.040 inch thickness overcoating of polyethylene, hot extruded over the undercoating. The overcoating shall be

free of surface blemishes, cracks, voids, and contamination from foreign substances. Field pipe joints and coating repairs shall be field applied coatings covered with heat-shrinkable pipe sleeves, following the cylinder manufacturer's instructions. Protect the AEC coating from damage until the cylinder is set into the cylinder well, plumbed, and aligned.

#### 2.3.5 Automatic Shutoff Valve

Provide automatic shut-off valve in oil supply line as close to cylinder inlet as possible. Provide threaded pipe connections to the valve. When there is ten percent drop in NO-LOAD operating pressure, automatic shut-off valve shall be activated. When activated, device shall immediately stop descent of elevator and hold elevator until lowered by use of manual lowering feature of valve. Arrange manual lowering feature of automatic shut-off valve to limit descending speed of elevator to 20 fpm. Exposed adjustments of automatic shut-off valve shall have means of adjustment sealed by certified elevator inspector after being set to correct position and tested in accordance with Paragraph Automatic Shutoff Valve Tests.

#### 2.3.6 Cylinder Well System

The cylinder well system shall consist of a well casing and a liner.

##### 2.3.6.1 Well Casing

Drill well for hydraulic cylinder, providing adequate depth, as indicated. Line well with steel casing with minimum wall thickness of 0.25 inch, and minimum inside diameter of not less than 5 inches larger than PVC liner maximum outside diameter, including cap and couplings. Close bottom of well casing with steel plate at least twice as thick as casing wall thickness, welded continuously all around, prior to insertion into well, or close well casing bottom by plugging with minimum of 6 inches of concrete, embedding casing bottom at least 2 inches but not more than 4 inches into the wet concrete. Install cylinder well casing not more than 1 inch out of plumb over entire length. Backfill the well outside of the casing with fine, dry, salt-free sand, as required to maintain casing straight and plumb, or backfill with bentonite grout if more than one water-bearing strata are penetrated by well. Maintain well casing pumped dry throughout remaining installation of elevator.

##### 2.3.6.2 PVC Liner

Provide Schedule 80 PVC pipe liner with bottom cap and couplings; joints sealed watertight using PVC pipe manufacturer's recommended adhesive or heat welding methods. Liner inside diameter not less than 3 inches larger than elevator cylinder maximum outside diameter. Set PVC liner into well casing, centered and plumb. Securely locate PVC liner bottom end within well casing with fine, dry, salt free sand.

##### 2.3.6.3 Pressure Test

Install pressure test cap onto PVC liner, equipped with at least: safety relief valve set to relieve at 30 psig; 4.5 inch diameter dial pressure gage scaled for 0 to 100 psig and calibrated to 0.5 percent accuracy; and an air pressure admission throttling and shutoff valve. Perform air pressure test by slowly admitting dry compressed air to pressurize PVC liner to 30 psig. Shut off air supply at throttle/shutoff valve, disconnect compressed air source, observe and record air pressure in PVC liner every 5 minutes for not less than 30 minutes. Liner shall not allow



drop in air pressure in excess of 0.5 psig over the 30 minute test period. Perform test in presence of the Elevator Inspector. Upon satisfactory completion of pressure test, remove test cap and dry interior of PVC liner. Upon failure of test, remove, repair, reinstall, and retest PVC liner until satisfactory. For safety, pressure test shall only be performed when liner is fully inserted in the well casing and well.

#### 2.3.6.4 Cylinder Installation

Remove surface moisture from inside of liner by wiping with dry cloth or purging with warm dry air prior to installing elevator cylinder. Install cylinder. Provide elevator manufacturer's recommended supports under cylinder head and attach cylinder head supports to cylinder and pit support channels in accordance with elevator manufacturer's instructions. Set cylinder into the pit. Plumb cylinder using "Spider-Bob" method.

#### 2.3.6.5 Casing Fill

Following cylinder installation, fill the space between PVC liner and steel casing with fine, dry, salt-free sand in 24 inch lifts with tamping between each lift. Continue filling with sand up to the level at the pit floor seal.

#### 2.3.6.6 Liner Inspection and Test Tube

Provide a 3/4 inch PVC test tube with strainer located within 6 inch of bottom of liner. Strainer shall exclude sand and admit air, water or oil. Provide top of test tube with removable cap to exclude foreign matter.

#### 2.3.6.7 Cylinder Bottom Location Fill

At the option of the contractor, clean dry sand may be used up to and not more than 24 inches above the bottom of the cylinder, to stabilize the cylinder. Remainder of the liner shall be empty.

#### 2.3.6.8 Seal

Seal gap between cylinder and PVC liner and gap between liner and well casing with foam insert strong enough to retain and support final grouting. Provide 3000 psi grout to a minimum of 4 inch thickness and level top of final grouting with pit floor.

#### 2.3.6.9 Containment

Protect exposed portions of hydraulic elevator oil supply line that are installed below ground, including portions encapsulated in concrete, or covered by construction, with continuous Schedule 80 PVC containment system, extending from machine room to elevator cylinder head connection. Coat and wrap line similar to elevator cylinder. Cap and seal containment system annular space.

#### 2.3.7 Motors

Provide NEMA MG 1 induction motors with squirrel cage, motors with drip-proof enclosure, continuous rated, maximum 1800 rpm, and Class F insulation rated at 120 starts per hour.

#### 2.3.7.1 Insulation Resistance and Motor Nameplate Data

Provide minimum of one megohm insulation resistance between conductors and motor frame. Provide motor nameplate listing rated wattage (horsepower), speed, and ampere, permanently mounted in position visible to viewer without use of special tools, such as a mirror. Provide motor and pump data on the outside of machine frame.

#### 2.3.7.2 Maximum Allowable Motor Amperage

When motor is running and elevator is lifting rated load at rated speed, motor shall not exceed its own nameplate amperage.

### 2.4 CONTROL EQUIPMENT

NFPA 70 and ASME A17.1, Section 3.26. Provide elevator motor controller of magnetic reduced-voltage resistance or wye-delta start with overload relays in each line and reverse phase relay. Provide controls for starting, stopping, and speed of elevator and to give specified operation. Enclose control equipment in factory-primed and baked-enamel coated sheet-metal cabinets with removable or hinged doors and ventilation louvers.

#### 2.4.1 Logic Control

Provide solid-state microprocessor controller to enable programmable control of call allocation, logic functions, door control, speed sensing and car position. Provide a method of reprogramming adjustable parameters of computerized controls. Store all programming in non-volatile memory. The microprocessor control system is acceptable only if hardware and software required to maintain and utilize microprocessor is provided and training is provided to Government Personnel by the equipment manufacturer and supplier. For the repair of microprocessor control system, provide maintenance tools, supporting computer software, and software documentation required for complete maintenance of elevator system including diagnostics and adjustments. Tools may be hand held or built into control system. Provide tools which do not require recharging to maintain their memory or authorization for use. Do not use software which requires periodic reprogramming, or reauthorization. Programs shall be stored in non-volatile memory. Tools and software may be factory programmed to operate only with this project's identification serial number.

#### 2.4.2 Self-Leveling and Anti-Creep Device

Provide elevator with two-way, automatic self-leveling device that brings car floor to within 1/4 inch of level with floor landing regardless of load, position of hoistway door, or direction of travel.

### 2.5 OPERATING PANELS, SIGNAL FIXTURES, AND COMMUNICATIONS CABINETS

#### 2.5.1 Capacity and Data Plates

Attach faceplates with spanner security screws. On car panel, provide stainless steel capacity and data plates, with name of elevator manufacturer.

#### 2.5.2 Car and Hall Buttons

Provide recessed tamper-proof push buttons of minimum 3/4 inch size satin-finish stainless steel, with illuminating jewel center.

### 2.5.3 Passenger Car-Operating Panel

Provide car with one car operating panel that contains operation controls and communication devices. Provide exposed, flush mounted buttons for the controls that must be passenger accessible. Provide service cabinet or keyed switches for those switches that should not be passenger accessible. Allow maximum 48 inches between car floor and center line of top operating buttons. Allow 35 inches between car floor and center line of bottom button. Use engraving and backfilling or photo etching for button and switch designations. Do not use attached signs.

## 2.6 PASSENGER CONTROLS

### 2.6.1 Passenger Car-Operating Panel

- a. Illuminating operating call buttons identified to correspond to landings served by elevator car.
- b. "DOOR OPEN" and "DOOR CLOSE" buttons.
- c. Keyed "STOP" switch in accordance with ASME A17.1, rule 2.26.2.
- d. "ALARM" button in compliance with UFAS, ADA, and ASME A17.1, Rule 2.27.1. Alarm button shall be red with engraved legend "ALARM." Alarm button shall illuminate when pushed. Locate "ALARM" button at panel bottom.
- e. "FIRE DEPARTMENT" key switch, with "OFF-HOLD-ON" positions, in that order with key to be removable in all positions. Provide fire sign or jewel, and audible signal device, in accordance with ASME A17.1 Section 2.27.3. Both visual and audible signals are activated when Phase I key switch in hall is activated or when smoke detector activates return of elevator(s) to main fire response floor. Visual and audible signal shall remain activated until car has reached main or designated alternate fire response floor. Upon arrival at fire response floor visual signal remains illuminated and audible signal becomes silent.
- f. Emergency two-way communication. Provide momentary pressure, single illuminating pushbutton operated communication device that complies with ASME A17.1, UFAS, and the Americans with Disabilities Act.

#### 2.6.1.1 Service Controls

- a. Inspection switch that transfers car control to top-of-car inspection operating controls and prevents car operation from in-car control panel.
- b. Independent service switch.
- c. Two car light switches, one for light in car and one for lights on top and bottom of car frame.
- d. Fan switch, two-speed.
- e. 120-volt ac 60 Hz single-phase duplex electrical outlet of ground-fault-circuit-interrupt (GFCI) design.

f. Device for communication between car and elevator machine room.

#### 2.6.1.2 Certificate Window

Provide 4 inch high by 6 inch wide certificate window in car operating panel for elevator inspection certificate.

#### 2.6.2 Switches and Devices

Provide elevator manufacturer's standard grade for switches and devices on car operating panel. Legibly and indelibly identify each device and its operating positions. Locate car dispatching buttons in identical positions in car operating panels for corresponding floors.

#### 2.6.3 In-Car Position and Direction Indicator and Signal

In-car direction indicator shall be included in the in-car position indicator fixture.

##### 2.6.3.1 In-Car Position Indicator and Signal

Provide horizontal electrical or electronic digital position indicator located minimum of 84 inches above car floor. Arrange indicator to show floor position of car in hoistway and its traveling direction. Indicate position by illuminating of numeral or letter corresponding to landing at which car is passing or stopping. Provide audible signal to alert passenger that elevator is passing or stopping at a floor. Provide audible signals exceeding ambient noise level by at least 20 dbA with frequency not higher than 1500 Hz.

##### 2.6.3.2 In-Car Direction Indicator and Signal

Provide visual and audible car direction indicators in car, indicating car traveling direction. For visual directional signal, provide arrow of minimum 2 1/2 inches in size. Use equilateral triangles for arrows, green for upward direction and red for downward direction. Provide audible signal that sounds once for upward direction and twice for downward direction.

#### 2.6.4 Landing Position and Direction Indicator and Signal

Provide a single fixture containing the landing position and direction indicator.

##### 2.6.4.1 Landing Position Indicator and Signal

Provide an electrical or electronic digital position indicator similar to the car position indicator. Arrange position indicator in wall horizontally above the door frame or vertically at the side of the door frame. Indicators to show floor position of car in hoistway. Indicate position by illumination of numeral or letter corresponding to landing at which car is passing or stopping.

##### 2.6.4.2 Landing Direction Indicator and Signal

Provide landing direction indicator with visual and audible signal devices. Provide single direction indicator at terminal floors; "UP" and "DOWN" direction indicator at intermediate floors. Provide equilateral triangles

not less than 2 1/2 inches in size, green for upward direction and red for downward direction. Provide electronic audible device that sounds once for upward direction and twice for downward direction. Provide audible signals exceeding ambient noise level by at least 20 decibels with frequency not higher than 1500 Hz.

## 2.7 HOISTWAY AND CAR EQUIPMENT

### 2.7.1 Guide Rails and Fastenings

Paint rail shanks with one coat black enamel. Only T-section type rail is acceptable.

### 2.7.2 Car Buffers

Provide buffer data plate on each buffer.

### 2.7.3 Pit Equipment

#### 2.7.3.1 Pit "STOP" Switch

Provide push/pull type pit "STOP" switch for stopping elevator motor, independent of regular operating device. Locate on same side of hoistway as ladder.

#### 2.7.3.2 Ladders

Section 05500A MISCELLANEOUS METALS. Locate ladder on hoistway side wall closest to hoistway door opening.

#### 2.7.3.3 Lighting of Pits

Locate pit light not less than 6 feet above pit floor. Locate switch on same side of hoistway as ladder. Provide GFCI duplex receptacle in each pit.

## 2.8 TERMINAL STOPPING DEVICES

Provide each elevator with a terminal stopping device.

### 2.8.1 Wiring and Traveling Cables

NFPA 70, Article 620 and Section 16415A ELECTRICAL WORK, INTERIOR. Suspend traveling cables by means of self-tightening webbed devices.

### 2.8.2 Emergency Signaling Device

Provide audible signaling device, operable from Car Operating Panel button marked "ALARM". The audible signaling device shall be mounted in hoistway.

## 2.9 PASSENGER CAR AND HOISTWAY DOOR ACCESSORIES

ASME A17.1, Sections 2.12, 2.13, 2.14, and 3. Provide infra-red curtain unit. Provide high-speed electric operator, safety interlocks for car and hoistway doors, and electric safety contact to prevent car operation unless doors are closed.

### 2.9.1 Infra-red Curtain Unit

Provide Infra-red Curtain Unit (ICU) with multiple infra-red beams that protect to the full height of the door opening. Minimum coverage shall extend from 2 inches off the floor to 70 inches above floor level. Door operation must meet the requirements of ASME A17.1 Rule 2.27.1 and 2.13.5.

## 2.10 PASSENGER ELEVATOR GUIDES, FRAME, PLATFORM, AND ENCLOSURE

### 2.10.1 Roller Guides

Provide roller guide assemblies in adjustable mountings on each side of car in accurate alignment at top and bottom of car frame.

### 2.10.2 Car Enclosure, Car Door, and Car Illumination

Provide natural and forced ventilation, stainless steel hooks, with fire retardant pads.

#### 2.10.2.1 Car Shell, Return Panels, Entrance Columns, Cove Base, and Transom

Provide 14 gauge minimum non perforated steel. Apply sound-deadening mastic on all exterior components.

#### 2.10.2.2 Car Top

Provide reinforced 12 gauge minimum steel with hinged emergency exit openable by hand from car top only. Provide electrical contact which prevents operation of elevator when emergency exit is open. Provide sound-deadening mastic on all exterior components.

#### 2.10.2.3 Car Door

Provide 16 gauge minimum steel, sandwich construction without binder angles. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading and one at trailing door edge with guides in the sill groove their entire length of travel.

#### 2.10.2.4 Car Entrance Sill

Provide one piece cast white bronze or nickel silver entrance sill. Set sills level and flush with floor finish. Use same material for hoistway and car entrance sills.

## 2.11 PASSENGER ELEVATOR HOISTWAY DOORS AND ENTRANCES

Provide hoistway entrance assemblies which have a minimum 1-1/2 hour fire rating.

### 2.11.1 Hoistway Entrance Frames

Frame of 14 gauge thick prefinished carbon sheet steel. Solidly grout uprights of entrances to height of 5 feet.

### 2.11.2 Hoistway Entrance Sills

Provide one-piece cast solid white bronze or nickel silver entrance sills. After sill is set level and flush with finished floor height, solidly grout under full length of sill. Use same material for hoistway and car door

sills.

#### 2.11.3 Hoistway Entrance Doors

Provide hoistway entrance door constructed with hollow metal non-vision construction with flush surfaces on car and landing sides. Provide a minimum of 2 door guide assemblies per door panel, one guide at leading edge and one at trailing door edge with guides in the sill groove the entire length of travel.

#### 2.11.4 Entrance Fascias and Dust Covers

Provide sheet metal hoistway door track dust covers at each landing. Dust covers must cover door locks and door roller tracks and extend the full width of the door track and associated hardware.

#### 2.11.5 Hoistway Ventilation

Provide hoistway ventilation directly to outside air by fixed louver through side wall of hoistway at top of hoistway. Net size of the louver shall be at least 3.5 percent of cross section of hoistway.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install in accordance with manufacturer's instructions, ASME A17.1, 36 CFR 1191, and NFPA 70.

##### 3.1.1 Traveling Cables

Do not allow abrupt bending of traveling cables.

##### 3.1.2 Automatic Shutoff Valve

Locate in supply-return line, as close as possible to cylinder-plunger unit.

##### 3.1.3 Structural Members

Do not cut or alter. Restore any damaged or defaced work to original condition.

##### 3.1.4 Safety Guards

Selector cables or tapes exposed to possibility of accidental contact in machine room shall be completely enclosed with 16 gage thick sheet metal or expanded metal guards, both horizontally and vertically. Exposed gears, sprockets, and selector drums shall be guarded from accidental contact in accordance with ASME A17.1.

##### 3.1.5 Miscellaneous Requirements

Include recesses, cutouts, slots, holes, patching, grouting, and refinishing to accommodate elevator installation. Use core drilling to drill all new holes in concrete. Finish work to be straight, level, and plumb. During installation, protect machinery and equipment from dirt, water, or mechanical damage. At completion, clean all work, and spot paint.

### 3.1.6 Firefighters' Service

Firefighters' service shall be complete including installation and wiring of all smoke detectors in accordance with ASME A17.1, Section 2.27.3.2. Coordinate smoke detector installation for firefighters' service.

## 3.2 FIELD QUALITY CONTROL

After completing elevators system installation, notify Contracting Officer that elevator system is ready for final inspection and acceptance test. Contractor shall perform all required tests and demonstrate proper operation of each elevator system and prove that each system complies with contract requirements and ASME A17.1, including Section 8.10.3, "Acceptance Inspection and Tests of Passenger and Freight Hydraulic Elevators", and the applicable requirements of Section 8.3, "Engineering and Type Tests". Inspection procedures in ASME A17.2.2 form a part of this inspection and acceptance testing. All testing and inspections shall be conducted in the presence of both the Elevator Specialist and the Elevator Inspector. Demonstrate the proper operation of all equipment at various date settings, selected by the Elevator Inspector, ranging from the date of contract award through 1 January 2099. The Elevator Inspector shall complete, sign and post the results of all tests and inspection results after successful completion of inspection and testing. The Contractor is responsible for all costs involved with reinspection and retesting required to correct discrepancies discovered during testing and the subsequent retesting required.

### 3.2.1 Testing Materials and Instruments

Furnish testing materials and instruments required for final inspection. Include calibrated test weights, tachometer, 600-volt megohm meter, volt meter and ammeter, three Celsius calibrated thermometers, door pressure gage, spirit level, stop watch, hydraulic pressure test gauge, and a 100 foot tape measure.

### 3.2.2 Field Tests

The Contractor shall submit Field Tests Reports after completing each of the specified tests, as required in the Submittals paragraph.

#### 3.2.2.1 Endurance Tests

Test each elevator for a period of one hour continuous run, with specified rated load in the car. Restart the one hour test period from beginning, following any shutdown or failure. During the test run, stop car at each floor in both directions of travel for standing period of 10 seconds per floor. The requirements for Rated Speed, Leveling, Temperature Rise, and Motor Amperes testing specified herein shall be met throughout the duration of the Endurance test.

#### 3.2.2.2 Automatic Shutoff Valve Tests

Test the automatic shutoff valve twice. Once at beginning of acceptance test and again at conclusion of one-hour Endurance test to ensure consistent performance of shutoff valve, regardless of temperature of equipment and oil.



### 3.2.2.3 Speed Tests

Determine actual speed of each elevator in both directions with rated load and with no load in elevator car. Make Speed tests before and immediately after Endurance test. Determine speed by tachometer reading, excluding accelerating and slow-down zones per ASME A17.2.2, Section 2.22.4. Minimum acceptable speed is the Rated Speed as specified. Maximum acceptable elevator speed is 110 percent of Rated Speed.

### 3.2.2.4 Leveling Tests

Test elevator car leveling devices for landing accuracy of plus or minus 1/4 inch at each floor with no load in car, symmetrical load in car, and with rated load in car in both directions of travel. Determine accuracy of floor landing both before and immediately after endurance tests.

### 3.2.2.5 Pressure Tests

Check operating pressure at pump and cylinder head under no load and rated load. Test pressure at which relief valve operates.

### 3.2.2.6 Insulation Resistance Tests

Perform tests to ensure wiring systems free from short circuits and grounds. Minimum acceptable insulation resistance for electrical conductors is one megohm between each conductor and ground and between each conductor and other conductors. Prior to megohm meter test, make provision to prevent damage to the electronic devices.

### 3.2.2.7 Temperature Rise Tests

Determine the temperature rise of the hydraulic pump motor during the full load test run for a minimum of one hour. Under these conditions, maximum acceptable temperature rise shall not exceed the acceptable temperature rise indicated on the manufacturer's data plate. Start test only when equipment is within 5 degrees C of ambient temperature.

### 3.2.2.8 Motor Ampere Tests

Measure and record motor amperage when motor is running and elevator is lifting at rated load and speed. Measure and record motor amperage at the beginning and the end of Endurance test.

## 3.3 OPERATION AND MAINTENANCE TRAINING

The Elevator Specialist shall instruct Government personnel in care, adjustment, and maintenance of elevator equipment for a period of not less than one working day immediately following acceptance of system. The Contractor shall submit Operation and Maintenance Manuals as required in the Submittals paragraph.

-- End of Section --

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## DIVISION 15 - MECHANICAL

## SECTION 15070A

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01/02

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## SECTION 15070A

SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION  
(SMACNA)

SMACNA Seismic Restraint Mnl (1998) Seismic Restraint Manual Guidelines  
for Mechanical Systems

U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04 (1998) Seismic Design for Buildings

## 1.2 SYSTEM DESCRIPTION

## 1.2.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the mechanical equipment and systems listed below. Structural requirements shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

## 1.2.2 Mechanical Equipment

Mechanical equipment to be seismically protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

Boilers	Water Heaters
Water and Gas Piping	Expansion Air and Separator Tanks
Valves and Fittings for Piping	Water Chiller Units
Air Compressors	Refrigerant Piping
Air Handling Units	Pumps with Motors
Ducts	Unit Heaters
Exhaust Fans	

## 1.2.3 Mechanical Systems

The following mechanical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

All Piping Inside the Building Except as Specifically Stated Below  
Under "Items Not Covered By This Section".  
Chilled Water Distribution Systems Outside of Buildings  
All Water Supply Systems

## Sanitary Sewer Systems

## 1.2.4 Items Not Covered By This Section

## 1.2.4.1 Fire Protection Systems

Seismic protection of piping for fire protection systems shall be installed as specified in Section 13930A WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION.

## 1.2.4.2 Items Requiring No Seismic Restraints

Seismic restraints are not required for the following items:

- a. Gas piping less than 1 inch inside diameter.
- b. Piping in boiler and mechanical equipment rooms less than 1-1/4 inches inside diameter.
- c. All other piping less than 2-1/2 inches inside diameter.
- d. Rectangular air handling ducts less than 6 square feet in cross sectional area.
- e. Round air handling ducts less than 28 inches in diameter.
- f. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.
- g. Ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions f. and g. all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced. Interior piping and ducts not listed above shall be seismically protected in accordance with the provisions of this specification.

## 1.3 EQUIPMENT REQUIREMENTS

## 1.3.1 Rigidly Mounted Equipment

The following specific items of equipment: The indicated equipment to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in TI 809-04, Chapter 10. Each item of rigid equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, duct, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

Boilers  
Chillers  
Air-Handling Units

## 1.3.2 Nonrigid or Flexibly-Mounted Equipment

The following specific items of equipment to be furnished: The indicated equipment shall be constructed and assembled to resist a horizontal lateral

force of pumps, fans, unit heaters times the operating weight of the equipment at the vertical center of gravity of the equipment.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Coupling and Bracing; G, AE  
Flexible Couplings or Joints; G, AE  
Equipment Requirements; G, AE

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

##### SD-03 Product Data

Coupling and Bracing; G, AE  
Equipment Requirements; G, AE

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

##### SD-07 Certificates

Flexible Ball Joints; G, AE

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer. Information verifying experience at not less than 3 locations of 2 years' satisfactory operation in a similar application shall be submitted.

## PART 2 PRODUCTS

### 2.1 FLEXIBLE COUPLINGS

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe.

### 2.2 FLEXIBLE BALL JOINTS

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation with not less than 15-degree angular movement.

### 2.3 FLEXIBLE MECHANICAL JOINTS

a. Mechanical couplings for steel or cast iron pipe shall be of the

sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

- b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets.

## 2.4 MANUFACTURED BALL JOINTS

Manufactured ball joints shall be as recommended by the manufacturer for the intended use, and shall be approved by the Contracting Officer before installation.

## 2.5 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

# PART 3 EXECUTION

## 3.1 COUPLING AND BRACING

Coupling installation shall conform to the details shown on the drawings. Provisions of this paragraph apply to all piping within a 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the most frequent interval as determined by applying the requirements of this specification to each piping run on the common support. Bracing components shall be sized as required for the total load carried by the common supports. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

## 3.2 BUILDING DRIFT

Joints capable of accommodating seismic displacements shall be provided for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Horizontal piping across expansion joints shall accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, swing joints made of the same piping material shall be provided. For piping with manufactured ball joints the seismic drift shall be 0.015 feet per foot of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

## 3.3 FLEXIBLE COUPLINGS OR JOINTS

### 3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers for pipe larger than 3-1/2 inches in diameter. Flexible couplings or joints shall be braced laterally without interfering with the

action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements.

### 3.3.2 Underground Piping

Underground piping and 4 inch or larger conduit shall have flexible couplings installed where the piping enters the building. The couplings shall accommodate 2 inches of relative movement between the pipe and the building in any direction. Additional flexible couplings shall be provided where shown on the drawings.

### 3.4 PIPE SLEEVES

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve. Pipe sleeves in fire rated walls shall conform to the requirements in Section 07840 FIRESTOPPING.

### 3.5 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.6 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

#### 3.6.1 Transverse Sway Bracing

Transverse sway bracing for steel and copper pipe shall be provided as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. All runs (length of pipe between end joints) shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400A PLUMBING, GENERAL PURPOSE.

#### 3.6.2 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided at 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

### 3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Vertical runs of piping shall be braced at not more than 10 foot vertical intervals. Braces for vertical runs shall be above the center of gravity of the segment being braced. All sway braces shall be constructed in accordance with the drawings. Sway branches shall not be connected to branch lines, walls, or floors.

### 3.6.4 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 3.7 SWAY BRACES FOR DUCTS

### 3.7.1 Braced Ducts

Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA Seismic Restraint Mnl, including Appendix E. However, the design seismic loadings for these items shall not be less than loadings obtained using the procedures in TI 809-04.

### 3.7.2 Unbraced Ducts

Hangers for unbraced ducts shall be attached to the duct within 2 inches of the top of the duct in accordance with SMACNA Seismic Restraint Mnl. Unbraced ducts shall be installed with a 6 inch minimum clearance to vertical ceiling hanger wires.

-- End of Section --



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## SECTION 15080A

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## SECTION 15080A

THERMAL INSULATION FOR MECHANICAL SYSTEMS  
07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209	(2001) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1290	(2000e1) Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(2000) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1995; R 2001) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(2001a) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(2000) Mineral Fiber Pipe Insulation
ASTM C 552	(2000) Cellular Glass Thermal Insulation
ASTM C 553	(2000) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 612	(2000a) Mineral Fiber Block and Board

## Thermal Insulation

ASTM C 647	(1995; R 2000) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 795	(1992; R 1998e1) Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 920	(2002) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000e1) Water Vapor Transmission of Materials

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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## MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1999) National Commercial & Industrial Insulation Standards
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## 1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Insulation of heat distribution systems and chilled water systems outside of buildings shall be as specified in Section 02555A PREFABRICATED UNDERGROUND COOLING DISTRIBUTION SYSTEM. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

## 1.3 GENERAL QUALITY CONTROL

## 1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

## 1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more

similar type jobs within the last 5 years.

#### 1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread, and smoke developed indexes, shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

#### 1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

General Materials; G, RE

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

#### 1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means.

### PART 2 PRODUCTS

#### 2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet

ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

#### 2.1.1 Adhesives

##### 2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

##### 2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

##### 2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

##### 2.1.2 Contact Adhesive

Adhesives may be dispersed in a volatile organic solvent. Adhesives may be any of, but not limited to, the neoprane based, rubber based, or elastomeric type that have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in the dry state in accordance with ASTM E 84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation shall be used to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

##### 2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

##### 2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

#### 2.1.5 Finishing Cement

ASTM C 449/C 449M: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

#### 2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

#### 2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel. Monel is a nickel rich alloy that has high strength, high ductility, and excellent resistance to corrosion.

#### 2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

##### 2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

##### 2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

### 2.1.9 Vapor Retarder Required

#### 2.1.9.1 Vapor Retarder Mastic Coatings

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

#### 2.1.9.2 Laminated Film Vapor Retarder

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

#### 2.1.10 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

#### 2.1.11 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

#### 2.1.12 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum moisture vapor transmission of 0.02 perms, and a maximum flame spread/smoke developed index of 25/50 per ASTM E 84.

## 2.2 PIPE INSULATION MATERIALS

The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

### 2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for outdoor, indoor, exposed or concealed applications, shall be as follows:

- a. Cellular Glass: ASTM C 552, Type II, and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

### 2.2.2 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket.

- a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the



insulation with manufacturer's recommended factory-applied jacket.

- b. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket.

#### 2.2.3 Above Ground Domestic Water Pipe

- a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

### 2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

#### 2.3.1 Rigid Mineral Fiber

ASTM C 612: Type IA, IB, II, III, & IV.

#### 2.3.2 Flexible Mineral Fiber

ASTM C 553: Type I, or Type II up to 250 F. ASTM C 1290 Type III.

### 2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

#### 2.4.1 Cold Equipment Insulation

For equipment operating temperatures below 60 degrees F.

##### 2.4.1.1 Cellular Glass

ASTM C 552: Type I, Type III, or Type IV as required.

##### 2.4.1.2 Flexible Elastomeric Cellular Insulation

ASTM C 534, Type II.

#### 2.4.2 Hot Equipment Insulation

For equipment operating temperatures above 60 degrees F.

##### 2.4.2.1 Rigid Mineral Fiber

ASTM C 612: Type IA, IB, II, III, IV, or V as required for temperatures encountered to 1800 degrees F.

##### 2.4.2.2 Flexible Mineral Fiber

ASTM C 553: Type I, II, III, IV, V, VI or VII as required for temperatures encountered to 1200 degrees F.

##### 2.4.2.3 Calcium Silicate

ASTM C 533, Type I, in-doors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200

degrees F.

### PART 3 EXECUTION

#### 3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

##### 3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests and heat tracing specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

##### 3.1.2 Fire-stopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

##### 3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTS AND COATINGS.

##### 3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

### 3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

### 3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

## 3.2 PIPE INSULATION INSTALLATION

### 3.2.1 Pipe Insulation

#### 3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.
- c. Sanitary drain lines.
- d. Air chambers.

#### 3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.
- c. Where pipes penetrate interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

- g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.
- h. For hot water pipes supplying lavatories or other similar heated service that requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. The annular space between the pipe and wall penetration shall be caulked with approved fire stop material. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inches.
- i. For domestic cold water pipes supplying lavatories or other similar cooling service that requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. The annular space between the outer surface of the pipe insulation and the wall penetration shall be caulked with an approved fire stop material having vapor retarder properties. The pipe and wall penetration shall be covered with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inches.

#### 3.2.1.3 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400A PLUMBING, GENERAL PURPOSE.
- c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass, calcium silicate (or perlite above 80 F), or the necessary strength polyisocyanurate shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness

as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

- d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.
- e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

#### 3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

#### 3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.

## 3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 30 degrees to plus 60 degrees F:

- a. Domestic cold water.
- b. Make-up water.
- c. Refrigerant suction lines.
- d. Chilled water.
- e. Air conditioner condensate drains.
- f. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

## 3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness  
Pipe Size (inches)

Type of Service	Material	Run-outs up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Refrigerant suction piping	FC		1.0	1.0	1.0	1.0	1.0
Chilled water supply & return temp piping	CG	1.5	1.5	1.5	2.0	2.0	2.0
	FC	0.5	1.0	1.0	1.0	1.0	1.0
Cold domestic water, above and below ceilings & makeup water	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	3/8	3/8	3/8	3/8	3/8	3/8
	PF	1.5	1.5	1.5	1.5	1.5	1.5
	MF	1.0	1.0	1.0	1.5	1.5	1.5
Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap personnel	FC	0.5	0.5	0.5	0.5	3/4	3/4
Air conditioning condensate drain located	FC		3/8	0.5	0.5	N/A	N/A

Table I - Cold Piping Insulation Thickness  
Pipe Size (inches)

Type of Service	Material	Run-outs up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
inside building							

\*When run-outs to terminal units exceed 12 feet, the entire length of run-out shall be insulated like main feed pipe. Insulations may not be applied if their flame and smoke developed ratings exceed the requirements of 25/50 established in this guide specification. Layered insulations, or installation where multiple layers of the same insulation are used, must be checked for this (in particular if the insulation has been rated per ASTM E 84 for one thickness).

LEGEND:

PF - Phenolic Foam  
CG - Cellular Glass  
MF - Mineral Fiber  
FC - Flexible Elastomeric Cellular  
PC - Polyisocyanurate Foam

3.2.2.2 Jacket for Mineral Fiber, Cellular Glass, Phenolic Foam, and Polyisocyanurate Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket. Insulation inside the building, to be protected with an aluminum jacket, shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 6 ft level shall be protected.

3.2.2.3 Insulation for Straight Runs (Mineral Fiber and Cellular Glass)

- a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per item "e." below. Note that staples are not required with cellular glass systems.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by

applying adhesive under the lap and then stapling.

- e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating or PVDC adhesive tape. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating or PVDC adhesive tape.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating or PVDC adhesive tape. The patch shall extend not less than 1-1/2 inches past the break.
- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating or PVDC adhesive tape.

#### 3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter.
- c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.
- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.
- e. Insulation shall be marked showing the location of unions, strainers, and check valves.



## 3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

## 3.2.3 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

- a. Domestic hot water supply & re-circulating system.
- b. Hot water heating.

## 3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

## LEGEND:

PF - Phenolic Foam  
 CG - Cellular Glass  
 CS - Calcium Silicate  
 MF - Mineral Fiber  
 FC - Flexible Elastomeric Cellular  
 PL - Perlite  
 PC - Polyisocyanurate Foam

Table II - Hot Piping Insulation Thickness  
 Pipe Size (inches)

Type of Service (degrees F)	Material	Run-outs up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Hot domestic water supply & re-circulating system, & water defrost lines (200 F max)**	.5 MF	0.5	1.5	1.5	1.5	1.5	1.5
Heating hot water, supply & return, & Heating oil (250 F max)	MF CS	0.5 1.0	1.5 1.5	1.5 2.0	2.0 2.5	2.5 2.5	3.0 3.0

Table II - Hot Piping Insulation Thickness  
Pipe Size (inches)

Type of Service (degrees F)	Material	Run-outs up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
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\* When run-outs to terminal units exceed 12 feet, the entire length of run-out shall be insulated like the main feed pipe.

\*\* Applies to re-circulating sections of service or domestic hot water systems and first 8 feet from storage tank for non-re-circulating systems.

### 3.2.3.2 Jacket for Insulated Hot Pipe

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

### 3.2.3.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is non-adhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

### 3.2.3.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12, and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation,

including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.
- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory pre-molded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory pre-molded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers.

#### 3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket shall be applied. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION.

##### 3.2.4.1 Aluminum Jacket

The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

##### 3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting

covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof.

### 3.2.5 Below ground Pipe Insulation

Shall be as specified in Section 02555A PREFABRICATED UNDERGROUND COOLING DISTRIBUTION SYSTEM.

## 3.3 DUCT INSULATION INSTALLATION

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed return ducts in air conditioned spaces where the difference between supply air temperature and room air temperature is less than 15 degrees F. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

### 3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (inches)

Cold Air Ducts	2.0
Fresh Air Intake Ducts	1.5

### 3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation on factory preinsulated sheet metal ducts may be omitted if insulation thickness is the same as shown hereinafter.

Insulation and vapor retarder shall be provided for the following cold air ducts and associated equipment.

- a. Supply ducts.
- b. Return air ducts.
- c. Plenums.
- d. Duct-mounted coil casings.
- e. Coil headers and return bends.
- f. Coil casings.
- g. Fresh air intake ducts.
- h. Filter boxes.
- i. Combustion air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf.

Insulation for round/oval ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I or II jacket; or, a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I or II all service jacket. Insulation for exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. See Drawings for specific insulation covering requirements in Locker Room Areas. Insulation on concealed duct shall be provided with a factory-applied Type I or II vapor retarder jacket. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings except firewall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any un-insulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

#### 3.3.2.1 Installation on Concealed Duct

- a. For rectangular, oval or round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.
- f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating or PVDC adhesive tape.
- g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor

retarder coating or PVDC adhesive tape.

- h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating or PVDC adhesive tape.
- i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

#### 3.3.2.2 Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.
- b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed or bent over.
- d. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of tape. Tape seams shall be sealed with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The

coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as per MICA standards.

### 3.3.3 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

### 3.3.4 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

## 3.4 EQUIPMENT INSULATION INSTALLATION

### 3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

- a. Hand-holes.
- b. Cleanouts.
- c. ASME stamps.
- d. Manufacturer's nameplates.

### 3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

- a. Pumps.
- b. Drip pans under chilled equipment.
- c. Cold water storage tanks.
- d. Duct mounted coils.
- e. Cold and chilled water pumps.
- f. Pneumatic water tanks.
- g. Air handling equipment parts that are not factory insulated.
- h. Expansion and air separation tanks.

#### 3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

- a. Equipment handling media between 35 and 60 degrees F: 1.5 inch thick cellular glass, 1 inch thick flexible elastomeric cellular, 1.5 inch thick phenolic foam, or 1 inch thick polyisocyanurate foam.
- b. Equipment handling media between 0 degree F and 34 degrees F: 3 inch thick cellular glass, 1 1/2 inch flexible elastomeric cellular, 1 1/2 inch thick phenolic foam, or 1 1/2 inch thick polyisocyanurate foam.
- c. Equipment handling media between minus 30 degrees F and 1 degree F: 3 1/2 inch thick cellular glass 1 3/4 inch thick flexible elastomeric cellular, 1 1/2 inch thick phenolic foam, or 1 1/2 inch thick polyisocyanurate foam.

#### 3.4.2.2 Pump Insulation

- a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.
- b. Exposed insulation corners shall be protected with corner angles.
- c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

#### 3.4.2.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. Cellular glass shall be installed in accordance with



manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.

- d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.
- e. Exposed insulation corners shall be protected with corner angles.
- f. Insulation on equipment with ribs shall be applied over 6 x 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch centers.

#### 3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

#### 3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

- a. Hot water generators.
- b. Water heaters.
- c. Pumps handling media above 130 degrees F.
- d. Hot water storage tanks.
- e. Air separation tanks.
- f. Surge tanks.

##### 3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table IV:

#### Legend

RMF: Rigid Mineral Fiber  
FMF: Flexible Mineral Fiber  
CS: Calcium Silicate  
PL: Perlite

CG: Cellular Glass  
 FC: Flexible Elastomeric Cellular  
 PF: Phenolic Foam  
 PC: Polyisocyanurate Foam

TABLE IV  
 Insulation Thickness for Hot Equipment (Inches)

Equipment handling steam or media to indicated pressure or temperature limit:	Material	Thickness
15 psig or 250F	RMF	2.0 inches
	FMF	2.0 inches
	CS/PL	4.0 inches
	CG	3.0 inches
	PF	1.5 inches
	FC (<200F)	1.0 inches
	PC	1.0 inches
200 psig or 400 F	RMF	3.0 inches
	FMF	3.0 inches
	CS/PL	4.0 inches
	CG	4.0 inches

#### 3.4.3.2 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing that does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

#### 3.4.3.3 Other Equipment

- Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound.

Mineral fiber joints shall be filled with finishing cement.

- d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.
- e. Exposed insulation corners shall be protected with corner angles.
- f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 x 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.
- g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.
- h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

#### 3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

-- End of Section --

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## SECTION 15181A

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## SECTION 15181A

## CHILLED AND HOT WATER PIPING AND ACCESSORIES

02/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22 (1999; 2001) Relief Valves for Hot Water Supply Systems

## ASTM INTERNATIONAL (ASTM)

ASTM A 106 (1999e1) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 182/A 182M (2001a) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

ASTM A 183 (1998) Carbon Steel Track Bolts and Nuts

ASTM A 193/A 193M (2001b) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 47/A 47M (1999) Ferritic Malleable Iron Castings

ASTM A 53/A 53M (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 536 (1984; R 1999e1) Ductile Iron Castings

ASTM A 653/A 653M (2001a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 733 (2001) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM B 32 (2000) Solder Metal

ASTM B 62 (1993) Composition Bronze or Ounce Metal Castings

ASTM B 75 (1999) Seamless Copper Tube

ASTM B 813	(2000) Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B 88	(1999e1) Seamless Copper Water Tube
ASTM D 2000	(2001) Rubber Products in Automotive Applications
ASTM D 3308	(2001) PTFE Resin Skived Tape
ASTM D 520	(2000) Zinc Dust Pigment
ASTM D 596	(2001) Reporting Results of Analysis of Water
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials
ASTM F 1199	(1988; R 1998) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2001) Water Pressure Reducing Valves
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## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints
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## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS BRH	(1991) Brazing Handbook
AWS D1.1/D1.1M	(2000) Structural Welding Code - Steel
AWS Z49.1	(1999) Safety in Welding, Cutting and Allied Processes

## ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose, Inch
ASME B16.11	(2001) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2001) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings



ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2001) Power Piping
ASME B31.9	(1996) Building Services Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2001) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

## HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps
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## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Gray Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and

## Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA MG 1 (1998) Motors and Generators

NEMA MG 2 (2001) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1999) Installation of Air Conditioning and Ventilating Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Piping System

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Piping layouts which identify all valves and fittings.
- b. Plans and elevations which identify clearances required for maintenance and operation.

## SD-03 Product Data

## Materials and Equipment; G, AE

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be provided for the following components as a minimum:

- a. Piping and Fittings
- b. Valves and Accessories
- c. Pumps
- d. Expansion Tanks
- e. Air Separator Tanks
- f. Pipe Hangers, Inserts, and Supports

#### Water Treatment Systems; G, RE

Six complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout, a list of existing make-up water conditions including the items listed in paragraph "Water Analysis", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

#### Spare Parts

Spare parts data for each different item of equipment specified.

#### Qualifications; G, RE

Six copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

#### Field Tests; G, RE

A schedule, at least 2 weeks prior to the start of related testing, for each test. The schedules shall identify the proposed date, time, and location for each test.

#### Demonstrations; G, RE

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

### SD-06 Test Reports

#### Field Tests; G, RE

Six copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. Reports shall document all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

#### One-Year Inspection; G, RE

Six copies of an inspection report, at the completion of one year of service, in bound 8 1/2 x 11 inch booklets. The report shall identify the condition of each cooling tower and condenser. The report shall also include a comparison of the condition of the

cooling tower and condenser with the manufacturer's recommended operating conditions. The report shall identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

#### SD-07 Certificates

Service Organization; G, RE

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

#### SD-10 Operation and Maintenance Data

Operation Manuals; G, RE

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; G, RE

Six complete copies of maintenance manual in bound 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping layouts and simplified wiring and control diagrams of the system as installed.

### 1.3 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record. Structural members shall be welded in accordance with Section 05120 STRUCTURAL STEEL.

### 1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## 1.6 PROJECT/SITE CONDITIONS

### 1.6.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.6.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

### 1.6.3 Spare Parts

The Contractor shall submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

## PART 2 PRODUCTS

### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

### 2.2 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, address, type or style,

model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

## 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 PIPING SYSTEM

System design, component selection, and system installation, including pressure containing parts and material, shall be based upon a minimum service pressure of 125 psi at 150 degrees F; minimum ANSI Class 125. Chilled and hot water piping shall be steel pipe with the exception that piping 4 inches and smaller may be copper tubing.

## 2.5 STEEL PIPE

Steel pipe shall conform to ASTM A 53/A 53M, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

### 2.5.1 Fittings and End Connections (Joints)

Fittings and end connections shall be as defined herein, except as identified elsewhere. Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, grooved, or welded connections. Piping and fittings 3 inches and larger shall have grooved, welded, or flanged connections. Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting

shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

#### 2.5.1.1 Threaded Connections

Threaded valves and pipe connections shall conform to ASME B1.20.1. Threaded fitting shall conform to ASME B16.3. Threaded unions shall conform to ASME B16.39. Threaded pipe nipples shall conform to ASTM A 733.

#### 2.5.1.2 Flanged Connections

Flanges shall conform to ASTM A 182/A 182M and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

#### 2.5.1.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

#### 2.5.1.4 Grooved Mechanical Connections

Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53/A 53M. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved mechanical connections shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183. Pipe connections and fittings shall be the product of the same manufacturer.

#### 2.5.1.5 Dielectric Waterways and Flanges

Dielectric waterways shall have a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Dielectric waterways shall be constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

### 2.6 COPPER PIPE

Copper pipe shall conform to ASTM B 88, Type K or L.

#### 2.6.1 Fittings and End Connections (Joints)

Wrought copper and bronze solder-joint pressure fittings shall conform to

ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

#### 2.6.1.1 Grooved Mechanical Connections

Grooved mechanical joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183. Pipe connections and fittings shall be the product of the same manufacturer.

#### 2.6.2 Solder

Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

#### 2.6.3 Brazing Filler Metal

Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

### 2.7 VALVES

Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor. Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

#### 2.7.1 Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

#### 2.7.2 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Globe and angle valves 3 inches and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged or threaded ends.



### 2.7.3 Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

### 2.7.4 Butterfly Valve

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves shall be bubble tight at 150 psig. Valve bodies shall be cast iron, malleable iron, or steel. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

### 2.7.5 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valve shall have weatherproof operators with mechanical position indicators. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

### 2.7.6 Ball Valve

Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

### 2.7.7 Calibrated Balancing Valve

Valve shall be calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valve's Cv rating shall be as indicated. Valve bodies shall be provided with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter, suitable for the operating pressure specified, shall be provided. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

### 2.7.8 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports shall have brass body and EPDM and/or

neoprene valve seals. Ports shall be rated for service between 35 and 275 degrees F and up to 500 psig. Ports shall be provided in lengths appropriate for the insulation thickness specified in Section 15080A MECHANICAL INSULATION and installed to allow a minimum of 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports shall be 1/4 inch NPT and accept 1/8 inch diameter.

#### 2.7.9 Pump Discharge Valve

Valve shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Valve shall have an integral pointer which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. Valve's Cv rating shall be as indicated.

#### 2.7.10 Pressure-Reducing Valve

Valve shall be in accordance with ASSE 1003 for water service.

#### 2.7.11 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve shall be in accordance with ANSI Z21.22 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

#### 2.7.12 Drain Valves

Valves shall be the gate valve type which are in accordance with MSS SP-80. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Valve shall be provided with a water hose nipple adapter. Frost-free type valves shall be provided in installations exposed to freezing temperatures.

#### 2.7.13 Air Vents

Manually-operated general service type air vents shall be brass or bronze valves which are furnished with threaded plugs or caps. Air vents on water coils shall have not less than 1/8 inch threaded end connections. Air vents on water mains shall have not less than 3/4 inch threaded end connections. Air vents on all other applications shall have not less than 1/2 inch threaded end connections.

### 2.8 PIPING ACCESSORIES

#### 2.8.1 Strainer

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Strainer shall be equipped

with removable cover and sediment screen. The screen shall be made of minimum 22 gauge monel with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

#### 2.8.2 Combination Strainer and Suction Diffuser

Unit shall consist of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and a blowdown outlet. Strainer shall be in accordance with ASTM F 1199, except as modified herein. Unit body shall have arrows clearly cast on the sides indicating the direction of flow. Strainer screen shall be made of minimum 22 gauge monel with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations.

#### 2.8.3 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psig or 150 psig service as appropriate for the static head plus the system head, and 230 degrees F, for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.8.4 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

#### 2.8.5 Temperature Gauges

Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor.

##### 2.8.5.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube

with indicating-fluid column.

#### 2.8.5.2 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

#### 2.8.6 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

#### 2.8.7 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

#### 2.8.8 Expansion Joints

Expansion loops shall be provided as shown on the Drawings.

### 2.9 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.5. Pump capacity, efficiency, motor size, and impeller type shall be as indicated on the drawings. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be splash-proof, and have sufficient horsepower for the service required. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

#### 2.9.1 Construction

Shaft seal shall be mechanical-seal type. Impeller shall be statically and dynamically balanced. Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water. Base-mounted pumps and motors shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Pump shall be provided with shaft coupling guard. Line-mounted pumps shall be suspended from construction. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump

shall be accessible for servicing without disturbing piping connections.

#### 2.9.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone separator in line.

#### 2.10 EXPANSION TANKS

Tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 125 psig and precharged to the minimum operating pressure. Tank shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

#### 2.11 AIR SEPARATOR TANKS

External air separation tank shall have an internal design suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 125 psig. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2 1/2 inches and larger. Air released from a tank shall be vented as indicated. Tank shall be provided with a blow-down connection.

#### 2.12 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

##### 2.12.1 Water Analysis

A water analysis for treatment of make-up water to be supplied to the hot and chilled water systems were reported in accordance with ASTM D 596 shall be provided by the Contractor.

##### 2.12.2 Chilled and Hot Water

Water to be used in the chilled and hot water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the heating and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

##### 2.12.3 Chilled and Hot Water System

A shot feeder shall be provided on the chilled and hot water piping as indicated. Size and capacity of feeder shall be based on local

requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

#### 2.12.4 Condenser Water

##### 2.12.4.1 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

#### 2.13 FABRICATION

##### 2.13.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

##### 2.13.2 Factory Applied Insulation

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

#### 2.14 SUPPLEMENTAL COMPONENTS/SERVICES

##### 2.14.1 Drain and Make-Up Water Piping

Piping and backflow preventers shall comply with the requirements of Section 15400A PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer system shall be connected by means of an indirect waste.

##### 2.14.2 Electric Heat Tape

Electric heat tape shall be self-regulating type, UL approved for use on above ground steel piping systems. See Drawings for capacity in watts/linear foot. Heat tape power shall be 120 volts, 1 phase. Provide thermostat control. See Drawings for installation details. Insulation shall be provided over heat tape. The tape shall be covered by a tinned copper braid to provide grounding and cable protection. Provide additional poly jacket over entire cable. Heat tape shall be provided on all above

ground, exterior chilled water supply and return piping and at all piping which may be subject to freezing temperatures.

#### 2.14.3 Field Applied Insulation

Field applied insulation shall be provided and installed in accordance with Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.15 DEHUMIDIFIERS

Dehumidifier shall have capacities as indicated on the Drawings. Dehumidifier shall be packaged electric with plug and cord, operating controls, wall brackets for wall mounting of unit, drip pan tray piped to drain, UL listed, with 5 year warranty on sealed refrigerant system, with frost control, with room cabinet with enameled finish.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

##### 3.1.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

##### 3.1.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges. Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

### 3.1.3 Fittings and End Connections

#### 3.1.3.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

#### 3.1.3.2 Brazed Connections

Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

#### 3.1.3.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

#### 3.1.3.4 Grooved Mechanical Connections

Grooves shall be prepared in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.1.3.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

#### 3.1.3.6 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control



valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

#### 3.1.4 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

#### 3.1.5 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

#### 3.1.6 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

#### 3.1.7 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

#### 3.1.8 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

#### 3.1.9 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

##### 3.1.9.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

#### 3.1.9.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

#### 3.1.9.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

#### 3.1.9.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

#### 3.1.9.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

#### 3.1.9.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

#### 3.1.9.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

#### 3.1.9.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

#### 3.1.9.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

#### 3.1.9.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

#### 3.1.9.11 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

#### 3.1.9.12 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

#### 3.1.10 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

#### 3.1.11 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

#### 3.1.12 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Standard weight. Sealants shall be applied

to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

#### 3.1.12.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900A JOINT SEALING.

#### 3.1.12.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

- a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.
- b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

#### 3.1.12.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840 FIRESTOPPING.

#### 3.1.12.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

#### 3.1.13 Pumps

Support, anchor, and guide so that no strains are imposed on pump by weight or thermal movement of piping. Air vents on pump casings shall be provided. Drain outlets on pump bases shall be piped to the nearest floor or other acceptable drains, with necessary clean-out tees.

#### 3.1.14 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

#### 3.1.15 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

#### 3.1.16 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

##### 3.1.16.1 Color Coding

Color coding for piping identification is specified in Section 09900 PAINTING, GENERAL.

##### 3.1.16.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

### 3.2 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

### 3.3 FIELD TESTS

Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government.

Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

#### 3.3.1 Hydrostatic Tests

Following the cleaning procedures defined above, all chilled and condenser water piping systems shall be hydrostatically tested as defined herein. Unless otherwise agreed by the Contracting Officer, water (or glycol solution) shall be the test medium.

##### 3.3.1.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the test pressure shall be properly isolated.

##### 3.3.1.2 Tests

Piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a calibrated, test pressure gauge. Leaks shall be repaired and piping retested until test is successful. No loss of pressure shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

#### 3.3.2 Backflow Prevention Assemblies Tests

Backflow prevention assemblies shall be tested in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

### 3.4 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff, as designated by the Contracting Officer, in accordance with the approved Operation Manuals. The training period shall consist of a total 16 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

### 3.5 ONE-YEAR INSPECTION

At the conclusion of the one year period, each connecting boiler and chiller shall be inspected for problems due to corrosion, scale, and biological growth. If the equipment is found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

-- End of Section --



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## SECTION 15182

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07/03

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## SECTION 15182

## REFRIGERANT PIPING

07/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 710	(1986) Liquid-Line Driers
ARI 750	(2001) Thermostatic Refrigerant Expansion Valves
ARI 760	(2001) Solenoid Valves for Use With Volatile Refrigerants

## ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2002a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 280	(2002) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 32	(2000e1) Solder Metal
ASTM B 62	(2002) Composition Bronze or Ounce Metal Castings
ASTM B 75	(2002) Seamless Copper Tube
ASTM B 813	(2000e1) Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube

## AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(2001; Errata 2002) Safety Standard for Refrigeration Systems
ASHRAE 17	(1998) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves

## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS BRH	(2002) Brazing Handbook
AWS Z49.1	(1999) Safety in Welding, Cutting and Allied Processes

## ASME INTERNATIONAL (ASME)

ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2001) Power Piping
ASME B31.5	(2001) Refrigeration Piping and Heat Transfer Components
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2002) Pipe Hangers and Supports - Selection and Application

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Refrigerant Piping System; G, RE

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Piping layouts which identify all valves and fittings.
- b. Plans and elevations which identify clearances required for maintenance and operation.

## SD-03 Product Data

### Refrigerant Piping System

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be provided for the following components as a minimum:

- a. Piping and Fittings
- b. Valves
- c. Piping Accessories
- d. Pipe Hangers, Inserts, and Supports

### Qualifications; G, RE

Six copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

### Refrigerant Piping Tests; G, RE

A schedule, at least 2 weeks prior to the start of related testing, for each test. The schedules shall identify the proposed date, time, and location for each test.

### Verification of Dimensions

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

## SD-06 Test Reports

### Refrigerant Piping Tests

Six copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. Reports shall document all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

## SD-07 Certificates

### Service Organization; G, RE

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## SD-10 Operation and Maintenance Data

Maintenance  
Operation and Maintenance Manuals

Data Package 2 in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Six complete copies of maintenance manual in bound 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping layouts and simplified wiring and control diagrams of the system as installed.

### 1.3 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record.

### 1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

### 1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

### 1.6 PROJECT/SITE CONDITIONS

#### 1.6.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.6.2 Contract Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

### 1.7 MAINTENANCE

Operation and maintenance data shall comply with the requirements of Section 01781 OPERATION AND MAINTENANCE DATA and as specified herein.

## PART 2 PRODUCTS

### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

### 2.2 ELECTRICAL WORK

Electrical equipment and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Field wiring shall be in accordance with manufacturer's instructions. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

### 2.3 REFRIGERANT PIPING SYSTEM

Refrigerant piping, valves, fittings, and accessories shall be in accordance with ASHRAE 15 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

### 2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

#### 2.4.1 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing

shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints.

Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

#### 2.4.2 Solder

Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

#### 2.4.3 Brazing Filler Metal

Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

### 2.5 VALVES

#### 2.5.1 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

#### 2.5.2 Expansion Valves

Valve shall conform to ARI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for

constant evaporator loads.

## 2.6 PIPING ACCESSORIES

### 2.6.1 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

### 2.6.2 Sight Glass and Liquid Level Indicator

#### 2.6.2.1 Assembly and Components

Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

#### 2.6.2.2 Bull's-Eye and Inline Sight Glass Reflex Lens

Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighting viewing shall be provided.

#### 2.6.2.3 Moisture Indicator

Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

### 2.6.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

### 2.6.4 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

## 2.7 FIELD APPLIED INSULATION

Field applied insulation shall be provided and installed in accordance with Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely



clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

#### 3.1.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

#### 3.1.2 Functional Requirements

Piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

#### 3.1.3 Fittings and End Connections

##### 3.1.3.1 Brazed Connections

Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations.

Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

#### 3.1.4 Valves

##### 3.1.4.1 General

Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with

isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensable gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

#### 3.1.4.2 Expansion Valves

Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall be installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

#### 3.1.5 Strainers

Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

#### 3.1.6 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

#### 3.1.7 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Sight glasses shall be full line size.

#### 3.1.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

##### 3.1.8.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

##### 3.1.8.2 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

#### 3.1.8.3 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

#### 3.1.8.4 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

#### 3.1.8.5 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping.

#### 3.1.8.6 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

#### 3.1.9 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Schedule 30. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

##### 3.1.9.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900A JOINT SEALING.

##### 3.1.9.2 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840 FIRESTOPPING.

##### 3.1.9.3 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms,

shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

#### 3.1.10 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

#### 3.1.11 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

#### 3.1.12 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTS AND COATINGS.

##### 3.1.12.1 Color Coding

Color coding for piping identification is specified in Section 09900 PAINTS AND COATINGS.

##### 3.1.12.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

### 3.2 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

### 3.3 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to pneumatic, evacuation, and startup tests as described herein. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section

## 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

## 3.3.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

## 3.3.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

## 3.3.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

#### 3.3.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures.

Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

#### 3.3.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

#### 3.3.6 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim.

At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

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## SECTION 15190A

## GAS PIPING SYSTEMS

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## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN GAS ASSOCIATION (AGA)

AGA XR0104 (2001) AGA Plastic Pipe Manual for Gas Service

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.24 (2001) Connectors for Gas Appliances

## AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D (2002) Specification for Pipeline Valves

## ASTM INTERNATIONAL (ASTM)

ASTM B 210 (2002) Aluminum and Aluminum-Alloy Drawn Seamless Tubes

ASTM B 241/B 241M (2002) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

ASTM B 280 (2002) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM B 88 (2002) Seamless Copper Water Tube

## ASME INTERNATIONAL (ASME)

ASME B1.20.1 (1983; R 2001) Pipe Threads, General Purpose, Inch

ASME B16.11 (2002) Forged Fittings, Socket-Welding and Threaded

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.3 (1998) Malleable Iron Threaded Fittings

ASME B16.33 (2002) Manually Operated Metallic Gas

Valves for Use in Gas Piping Systems Up to  
125 psig, Sizes NPS 1/2 - NPS 2

ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2001) Power Piping
ASME B31.2	(1968) Fuel Gas Piping
ASME B36.10M	(2001) Welded and Seamless Wrought Steel Pipe
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2002) Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 70	(2002) National Electrical Code

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6	(2000) Commercial Blast Cleaning
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UNDERWRITERS LABORATORIES (UL)

UL Gas&Oil Dir	(2000) Gas and Oil Equipment Directory
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System

Drawings showing location, size and all branches of pipeline;

location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

#### SD-03 Product Data

Welding; G, RE

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

#### SD-06 Test Reports

Testing; G, RE

Pressure Tests; G, RE

Test With Gas; G, RE

Test reports in booklet form tabulating test and measurements performed. The reports shall be dated after award of this contract, shall state the contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

### 1.3 GENERAL REQUIREMENTS

#### 1.3.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05120 STRUCTURAL STEEL.

#### 1.3.2 Jointing Thermoplastic and Fiberglass Piping

Piping shall be jointed by performance qualified joiners using qualified procedures in accordance with AGA XR0104. Plastic Pipe Manual for Gas Service. The Contracting Officer shall be furnished with a copy of qualified procedures and list of and identification symbols of qualified joiners.

#### 1.3.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

#### 1.3.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### PART 2 PRODUCTS

#### 2.1 PIPE AND FITTINGS

##### 2.1.1 Steel Pipe, Joints, and Fittings

Steel pipe shall conform to ASME B36.10M. Malleable-iron threaded fittings shall conform to ASME B16.3. Steel pipe flanges and flanged fittings including bolts, nuts, and bolt pattern shall be in accordance with ASME B16.5. Wrought steel butt welding fittings shall conform to ASME B16.9. Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

##### 2.1.2 Aluminum Alloy Pipe and Tubing, Joints, and Fittings

Aluminum alloy pipe shall conform to ASTM B 241/B 241M, except alloy 5456 shall not be used, and the ends of each length of pipe shall be marked indicating it conforms to NFPA 54. Pipe joints shall be threaded, flanged, brazed or welded. Aluminum alloy tubing shall conform to , ASTM B 210, Type A or B, or ASTM B 241/B 241M, Type A or equivalent. Tubing joints shall be made up with gas tubing fittings recommended by the tubing manufacturer.

##### 2.1.3 Copper Tubing, Joints and Fittings

Copper tubing shall conform to ASTM B 88, Type K or L, or ASTM B 280. Tubing joints shall be made up with tubing fittings recommended by the tubing manufacturer.

##### 2.1.4 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL Gas&Oil Dir, Class 20 or less. Tetrafluoroethylene tape shall conform to UL Gas&Oil Dir.

##### 2.1.5 Identification

Pipe flow markings and metal tags shall be provided as required.

##### 2.1.6 Flange Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service. NBR binder shall be used for hydrocarbon service.

##### 2.1.7 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

##### 2.1.8 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either

one piece or split pattern, held in place by internal spring tension or set screw.

#### 2.1.9 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing metallic and thermoplastic or fiberglass pipe. Approved transition fittings are those that conform to AGA XR0104 requirements for transitions fittings.

#### 2.1.10 Insulating Pipe Joints

##### 2.1.10.1 Insulating Joint Material

Insulating joint material shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

##### 2.1.10.2 Threaded Pipe Joints

Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

##### 2.1.10.3 Flanged Pipe Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

#### 2.1.11 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.24.

### 2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

#### 2.2.1 Valves 2 Inches and Smaller

Valves 2 inches and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

#### 2.2.2 Valves 2-1/2 Inches and Larger

Valves 2-1/2 inches and larger shall be carbon steel conforming to API Spec 6D, Class 150.

### 2.3 PIPE HANGERS AND SUPPORTS

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

### 2.4 REGULATORS AND SHUTOFF VALVES

Regulators and shutoff valves shall be as specified in Section 02556A GAS DISTRIBUTION SYSTEM.

## PART 3 EXECUTION

### 3.1 GAS PIPING SYSTEM

Gas piping system shall be from the point of delivery, defined as the outlet of the service regulator specified in Section 02556A GAS DISTRIBUTION SYSTEM, to the connections to each gas utilization device.

#### 3.1.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

#### 3.1.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.

### 3.2 PROTECTIVE COVERING

#### 3.2.1 Aboveground Metallic Piping Systems

##### 3.2.1.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, loose mill scale and other foreign substances shall be mechanically cleaned by power wire brushing or commercial sand blasted conforming to SSPC SP 6 and primed with ferrous metal primer or vinyl type wash coat. Primed surface shall be finished with two coats of exterior oil paint or vinyl paint.

##### 3.2.1.2 Nonferrous Surfaces

Except for aluminum alloy pipe, nonferrous surfaces shall not be painted. Surfaces of aluminum alloy pipe and fittings shall be painted to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. The surfaces shall be solvent-cleaned and treated with vinyl type wash coat. A first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel shall be applied.

### 3.3 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, AGA XR0104, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used.

### 3.3.1 Metallic Piping Installation

Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Aluminum alloy pipe shall not be used in exterior locations or underground.

### 3.3.2 Metallic Tubing Installation

Metallic tubing shall be installed using gas tubing fittings approved by the tubing manufacturer. Branch connections shall be made with tees. All tubing end preparation shall be made with tools designed for the purpose. Aluminum alloy tubing shall not be used in exterior locations or underground.

### 3.3.3 Concealed Piping in Buildings

When installing piping which is to be concealed, unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combinations of fittings shall not be used.

#### 3.3.3.1 Piping in Partitions

Concealed piping shall be located in hollow rather than solid partitions. Tubing passing through walls or partitions shall be protected against physical damage.

### 3.3.4 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported. Exposed horizontal piping shall not be installed farther than 6 inches from nearest parallel wall in laundry areas where clothes hanging could be attempted.

### 3.3.5 Final Gas Connections

Unless otherwise specified, final connections shall be made with rigid metallic pipe and fittings. Flexible connectors may be used for final connections to gas utilization equipment. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each gas equipment item.

### 3.3.6 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as shown on the drawings.

## 3.4 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

### 3.4.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

### 3.4.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

### 3.4.3 Flared Metallic Tubing Joints

Flared joints in metallic tubing shall be made with special tools recommended by the tubing manufacturer. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Metallic ball sleeve compression-type tubing fittings shall not be used for tubing joints.

### 3.4.4 Solder or Brazed Joints

Joints in metallic tubing and fittings shall be made with materials and procedures recommended by the tubing supplier. Joints shall be brazed with material having a melting point above 1000 degrees F. Brazing alloys shall not contain phosphorous.

## 3.5 PIPE SLEEVES

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Sleeves in mechanical room floors above grade shall extend at least 4 inches above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 1/4 inch all around the pipe. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, the annular space between the pipe and sleeve shall be sealed with firestopping material and sealant that meet the requirement of Section 07840 FIRESTOPPING.



### 3.6 PIPES PENETRATING WATERPROOFING MEMBRANES

Pipes penetrating waterproofing membranes shall be installed as specified in Section 15400A PLUMBING, GENERAL PURPOSE.

### 3.7 FIRE SEAL

Penetrations of fire rated partitions, walls and floors shall be in accordance with Section 07840 FIRESTOPPING.

### 3.8 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

### 3.9 SPECIAL REQUIREMENTS

Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall conform to the requirements of NFPA 54.

### 3.10 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched. Piping supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer.

### 3.11 PIPING SYSTEM SUPPORTS

Gas piping systems in buildings shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 1/8 inch shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

### 3.12 ELECTRICAL BONDING AND GROUNDING

The gas piping system within the building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70. Conventional flange joints allow sufficient current flow to satisfy this requirement.

### 3.13 SHUTOFF VALVE

Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

### 3.14 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.

#### 3.14.1 Pressure Tests

Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 0.1 pound. The source of pressure shall be isolated before the pressure tests are made.

#### 3.14.2 Test With Gas

Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

#### 3.14.3 Purging

After testing is completed, and before connecting any appliances, all gas piping shall be fully purged. LPG piping tested using fuel gas with appliances connected does not require purging. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

#### 3.14.4 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

### 3.15 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

-- End of Section --

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## SECTION 15400A

PLUMBING, GENERAL PURPOSE  
09/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

- |          |   |
|----------|---|
| ARI 1010 | (1994) Self-Contained, Mechanically Refrigerated Drinking-Water Coolers |
| ARI 700  | (1999) Specifications for Fluorocarbon Refrigerants                     |

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |               |   |
|---------------|---|
| ANSI Z21.10.1 | (2001) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less                            |
| ANSI Z21.10.3 | (2001) Gas Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous |
| ANSI Z21.22   | (1999; A 2001) Relief Valves for Hot Water Supply Systems   |
| ANSI Z21.56   | (2001) Gas-Fired Pool Heaters   |
| ANSI Z124.5   | (1997) Plastic Toilet (Water Closet) Seats  |

## ASTM INTERNATIONAL (ASTM)

- |                   |   |
|-------------------|---|
| ASTM A 105/A 105M | (2002) Carbon Steel Forgings for Piping Applications  |
| ASTM A 183        | (1998) Carbon Steel Track Bolts and Nuts  |
| ASTM A 193/A 193M | (2001b) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service        |
| ASTM A 47/A 47M   | (1999) Ferritic Malleable Iron Castings   |
| ASTM A 515/A 515M | (2001) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |

ASTM A 516/A 516M	(2001) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 1999e1) Ductile Iron Castings
ASTM A 733	(2001) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 888	(1998e1) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 152/B 152M	(2000) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 32	(2000e1) Solder Metal
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM B 42	(2002) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1998) Seamless Red Brass Pipe, Standard Sizes
ASTM B 584	(2000) Copper Alloy Sand Castings for General Applications
ASTM B 75	(2002) Seamless Copper Tube
ASTM B 813	(2000e1) Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B 828	(2002) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM B 88	(2002) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(2002) Elastomeric Joint Sealants
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(2001) Rubber Products in Automotive

## Applications

ASTM D 2235	(2001) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(2001) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2447	(2001) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2002) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2002) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2002) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2661	(2002) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(2002a) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(2001) Polyethylene (PE) Plastic Tubing
ASTM D 2822	(1991; R 1997e1) Asphalt Roof Cement
ASTM D 2846/D 2846M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D 2855	(1996; R 2002) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(2001) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe



ASTM D 3035	(2001) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3138	(2002) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(2001) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4551	(1996; R 2001) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM D 638	(2002) Tensile Properties of Plastics
ASTM E 1	(2001) ASTM Thermometers
ASTM E 96	(2000e1) Water Vapor Transmission of Materials
ASTM F 1760	(2001) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F 409	(2002) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F 437	(1999) Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 438	(2002) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F 439	(2002) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(1999e1) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

ASTM F 442/F 442M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(2002e1) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 628	(2001) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 877	(2002a) Crosslinked Polyethylene (PEX) Plastic Hot- and Cold- Water Distribution Systems
ASTM F 891	(2000e1) Coextruded Poly (Vinyl chloride) (PVC) Plastic Pipe with a Cellular Core

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 34	(2001; Errata 2002) Designation and Safety Classification of Refrigerants
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AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2002) Atmospheric Type Vacuum Breakers
ASSE 1003	(2001) Water Pressure Reducing Valves
ASSE 1005	(1999) Water Heater Drain Valves
ASSE 1010	(1996) Water Hammer Arresters
ASSE 1011	(1993) Hose Connection Vacuum Breakers
ASSE 1012	(2002) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1999) Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
ASSE 1018	(2001) Trap Seal Primer Valves, Water Supply Fed
ASSE 1020	(1998) Pressure Vacuum Breaker Assembly
ASSE 1037	(1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1999) Liquid Chlorine
AWWA C203	(2002; A C203a-99) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C651	(1999) Disinfecting Water Mains
AWWA C652	(2002) Disinfection of Water-Storage Facilities
AWWA EWW	(1998) Standard Methods for the Examination of Water and Wastewater

## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

## ASME INTERNATIONAL (ASME)

ASME A112.1.2	(1991; R 2002) Air Gaps in Plumbing Systems
ASME A112.18.1	(2000) Plumbing Fixture Fittings
ASME A112.19.2M	(1998) Vitreous China Plumbing Fixtures
ASME A112.19.3	(2001) Stainless Steel Fixtures (Designed for Residential Use)
ASME A112.36.2M	(1991; R 2002) Cleanouts
ASME A112.6.1M	(1997; R 2002) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2000) Floor and Trench Drains
ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose, Inch
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(2002) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(2002) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(2002) Cast Copper Alloy Pipe Flanges and

	Flanged Fittings: Classes 150, 300, 400, 600, 900, 1500, and 2500
ASME B16.29	(2002) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.34	(1996) Valves Flanged, Threaded, and Welding End
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B31.1	(2001) Power Piping
ASME B31.5	(2001) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2000) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2001) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(2002) Control and Safety Devices for Automatically Fired Boilers
CAST IRON SOIL PIPE INSTITUTE (CISPI)	
CISPI 301	(2000) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
COPPER DEVELOPMENT ASSOCIATION (CDA)	
CDA A4015	(1994; R 1995) Copper Tube Handbook
FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)	
FCCCHR Manual	(9th Edition) Manual of Cross-Connection Control

## INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (2003) Accessible and Usable Buildings and Facilities

ICC IPC (2000) International Plumbing Code

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110 (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-25 (1998) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-44 (1996; R 2001) Steel Pipe Line Flanges

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-67 (2002) Butterfly Valves

MSS SP-69 (2002) Pipe Hangers and Supports - Selection and Application

MSS SP-70 (1998) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1997) Gray Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-72 (1999) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-73 (1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings

MSS SP-78 (1998) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-83 (2001) Class 3000 Steel Pipe Unions Socket-Welding and Threaded

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

## NACE INTERNATIONAL (NACE)

NACE RP0169 (2002) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (2002) National Fuel Gas Code

NFPA 90A (2002) Installation of Air Conditioning  
and Ventilating Systems

## NSF INTERNATIONAL (NSF)

NSF 14 (2003) Plastics Piping Components and  
Related Materials

NSF 61 (2002e) Drinking Water System Components -  
Health Effects

## PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01 (1998) Plastic Pipe in Fire Resistive  
Construction

## PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201 (1992) Water Hammer Arresters

## SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508 (1997) Hose Clamp Specifications

## U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

PL 93-523 (1974; A 1999) Safe Drinking Water Act

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 50.12 National Primary and Secondary Ambient Air  
Quality Standards for Lead

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Plumbing System

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system

including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

#### Electrical Work

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

#### SD-03 Product Data

##### Welding

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

##### Plumbing Fixture Schedule; G, AE

Catalog cuts of specified plumbing fixtures, valves, related piping system and system location where installed.

##### Vibration-Absorbing Features; G, RE

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

##### Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

#### SD-06 Test Reports

##### Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

##### Test of Backflow Prevention Assemblies; G, RE

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

## SD-07 Certificates

## Materials and Equipment

Where materials or equipment are specified to comply with requirements of AGA, ASME, or NSF proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

## Bolts

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

## SD-10 Operation and Maintenance Data

## Plumbing System; G, RE

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

## 1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

## 1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.



## 1.5 PERFORMANCE REQUIREMENTS

### 1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record. Structural members shall be welded in accordance with Section 05120 STRUCTURAL STEEL.

## 1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

## 1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II.

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system.

#### 2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310
- b. Coupling for Steel Pipe: AWWA C606.

- c. Couplings for Grooved Pipe: Malleable Iron ASTM A 47/A 47M, Grade 32510, Copper ASTM A 536.
- d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- e. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.
- f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
- g. Solder Material: Solder metal shall conform to ASTM B 32.
- h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.
- i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.
- j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.
- k. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 230 degrees F.
- l. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.
- m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.
- n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.
- o. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.
- p. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.
- q. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

#### 2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrester: PDI WH 201.

- b. Copper, Sheet and Strip for Building Construction: ASTM B 370.
- c. Asphalt Roof Cement: ASTM D 2822.
- d. Hose Clamps: SAE J1508.
- e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
- f. Metallic Cleanouts: ASME A112.36.2M.
- g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
- h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.
- i. Hypochlorites: AWWA B300.
- j. Liquid Chlorine: AWWA B301.
- k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.
- l. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

#### 2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

#### 2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends	

Description for General Service	Standard MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Vacuum Relief Valves	ANSI Z21.22
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1  Safety Code No., Part CW, Article 5

#### 2.3.1 Wall Faucets or Hose Bibbs

Wall faucets or hose bibbs shall be provided with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

#### 2.3.2 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

#### 2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of

heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

#### 2.3.4 Thermostatic Mixing Valves

Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

#### 2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.

Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, and pop-up stoppers of lavatory waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

##### 2.4.1 Lavatories

Enameled cast-iron lavatories shall be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets shall be porcelain enameled.

#### 2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For

Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR Manual. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

## 2.6 DRAINS

### 2.6.1 Floor and Shower Drains

Floor and shower drains shall consist of a galvanized body unless otherwise noted, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with a threaded or spigot connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.6.3.

#### 2.6.1.1 Drains

Drains installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

#### 2.6.2 Floor Drain Type "A"

Drains shall be plain pattern with polished stainless steel or brass perforated or slotted grate and bottom outlet. The drain shall be circular or square with an 8 inch nominal overall width. Single unit shower drains shall have a 4 inch minimum strainer width. Drains shall be cast iron with manufacturer's standard coating. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.6.3.

#### 2.6.3 Boiler Room Drains F.D. Type "B"

Boiler room drains shall have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 4 inches. The grate area shall be not less than 100 square inches.

#### 2.6.4 Floor Drain Type "C"

Floor drain Type "C" drain shall be same as Floor Drain Type "A" except modified with a 4 inch high by 4 inch wide funnel drain attached to top grating.

### 2.6.5 Shower Trench Drain

The shower trench drain shall be manufactured from precast polymer concrete designed to slope at 0.6 inch per foot from end to center. The drain shall be approximately 4 inches wide and 120 inches long, designed for personnel traffic. The drain shall be provided with end caps and a bottom drain in the center length. The connecting joints shall be connected by interlocking tongue and groove ends. Anchor ribs on the outside of the channel walls provide anchorage in the poured concrete floor. A stainless steel channel frame shall be connected to the top of the channel to receive the cover. The cover shall be light-duty type with a perforated face with 1/4 inch diameter drainage openings. The channel frame and the cover will be provided with locking devices for attachment, anchoring, and removing. The top of the drain shall be set level with the finish floor. The entire bottom and sides shall be embedded in concrete. Provide any special tools for the grate cover required for removal.

### 2.7 SHOWER PAN

Shower pan may be copper, or nonmetallic material.

#### 2.7.1 Sheet Copper

Sheet copper shall be 16 ounce weight.

#### 2.7.2 Plasticized Polyvinyl Chloride Shower Pan Material

Material shall be sheet form. The material shall be 0.040 inch minimum thickness of plasticized polyvinyl chloride or chlorinated polyethylene and shall be in accordance with ASTM D 4551.

#### 2.7.3 Nonplasticized Polyvinyl Chloride (PVC) Shower Pan Material

Material shall consist of a plastic waterproofing membrane in sheet form. The material shall be 0.040 inch minimum thickness of nonplasticized PVC and shall have the following minimum properties:

a. or ASTM D 638:

Ultimate Tensile Strength:	2600 psi
Ultimate Elongation:	398 percent
100 Percent Modulus:	445 psi

b. ASTM D 1004:

Tear Strength:	300 pounds per inch
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c. ASTM E 96:

Permeance:	0.008 perms
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d. Other Properties:

Specific Gravity:	1.29
PVC Solvent:	Weldable
Cold Crack:	minus -53 degrees F
Dimensional stability,	
212 degrees F minus 2.5 percent	

Hardness, Shore A:

89

## 2.8 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

## 2.9 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each gas-fired water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The unit shall be furnished with a fan assist draft fan. Vent stack shall be furnished and installed under Section 15569A, WATER HEATING; GAS UP TO 20 MBTUH.

### 2.9.1 Automatic Storage Type

Heaters shall be complete with control system and shall have ASME rated combination pressure and temperature relief valve. Tank shall be entirely lined after fabrication using a thermoplastic polymer that is NSF 61 approved and consists of FDA compliant materials. The lining shall be provided with multiple applications creating a continuous and non-porous barrier with no interruptions including tank to fitting transitions.

#### 2.9.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3 for heaters with input greater than 75,000 BTU per hour.

## 2.10 PUMPS

### 2.10.1 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended



service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover. Pump motors smaller than Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

## 2.10.2 Booster Pumps

### 2.10.2.1 Controls

Each pump motor shall be provided with enclosed across-the-line-type magnetic controller complete in a NEMA 250 Type 1 enclosure with three position, "HAND-OFF-AUTOMATIC," selector switch in cover. Pumps shall be automatically started and stopped by float or pressure switches, as indicated. The pump shall be started by a temperature sensor when return temperature drops below 105 degree F and stopped when return water rises above 105 degrees F. The DDC control system shall start and stop the pump during unoccupied periods.

## 2.11 COMPRESSED AIR SYSTEM

### 2.11.1 Air Compressor

Air compressor unit shall be a factory-packaged assembly, including 3 phase, 480 volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type 1 enclosure. Tank-mounted air compressor shall be manufactured to comply with UL listing requirements. Air compressor shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment.

The compressor shall start and stop automatically at upper and lower pressure limits of the system. Guards shall shield exposed moving parts. The compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided for each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensate before the air enters the receiver. Aftercoolers shall be air-cooled. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressor. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

### 2.11.2 Air Receivers

Receivers shall be designed for 200 psi working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPVC SEC VIII D1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved

independent testing laboratory indicating conformance to the ASME Code shall be provided.

#### 2.11.3 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 125 psi, capacity as indicated.

#### 2.11.4 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 125 psi and a maximum temperature of 200 degrees F. Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 to 125 psi. Regulator shall be sized as indicated.

#### 2.11.5 Air Hose

Provide 3/8 inch nylon coil air hose, 12 foot total length, extruded from heavy duty Nylon II. Hose shall be oil, grease and moisture resistant, rated at 170 psig maximum working pressure at -40 degrees F through 200 degrees F temperature. Hose shall be a yellow color. Provide quick-connect coupling for connection to air tools. Quick connector shall be all brass.

### PART 3 EXECUTION

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A gate valve or full port ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place.

Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

##### 3.1.1 Water Pipe, Fittings, and Connections

###### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to

permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

#### 3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

#### 3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

#### 3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

#### 3.1.1.5 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided,

toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

#### 3.1.1.6 Thrust Restraint (Below Ground)

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

#### 3.1.1.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

#### 3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be installed as specified for water piping and suitable for 125 psig working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

#### 3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

##### 3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

##### 3.1.3.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling

manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.1.3.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

#### 3.1.3.4 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.3.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

#### 3.1.3.6 Copper Tube and Pipe

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.
- c. Copper Tube Extracted Joint. Mechanically extracted joints shall be made in accordance with ICC IPC.

#### 3.1.3.7 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with

solvent cement. PVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

#### 3.1.3.8 Other Joint Methods

#### 3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

#### 3.1.5 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Coatings shall be selected, applied, and inspected in accordance with NACE RP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

#### 3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

##### 3.1.6.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing

through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900A JOINT SEALING. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07840 FIRESTOPPING.

#### 3.1.6.2 Flashing Requirements

Pipes passing through roof shall be installed in complete accordance with the Metal Roof Manufacturer's recommendations through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

#### 3.1.6.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be

lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

#### 3.1.6.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

#### 3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07900A JOINT SEALING.

#### 3.1.7 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

#### 3.1.8 Supports

##### 3.1.8.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

##### 3.1.8.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as shown. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used



for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

#### 3.1.8.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
  - (1) Be used on insulated pipe less than 4 inches.
  - (2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
  - (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads

encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

- (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
  - (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
  - (3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
  - m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.
  - n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

#### 3.1.8.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

#### 3.1.9 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.10 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

## 3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

### 3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

### 3.2.2 Installation of Gas-Fired Water Heater

Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

### 3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

### 3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

## 3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

### 3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

### 3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Installation of fixtures for use by the physically handicapped shall be in accordance with ICC A117.1.

#### 3.3.4 Shower Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

#### 3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

##### 3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

##### 3.3.5.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

##### 3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

##### 3.3.5.4 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

#### 3.3.6 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each

device shall be a standard commercial unit.

### 3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

### 3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

### 3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

### 3.3.10 Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

#### 3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 6 inches for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

#### 3.3.10.2 Nonplasticized Chlorinated Polyethylene Shower Pans

Corners of nonplasticized chlorinated polyethylene shower pans shall be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp shall be used in making corner folds. Each pig-ear corner fold shall be nailed or stapled 1/2 inch from the upper edge to hold it in place. Nails shall be galvanized large-head roofing nails. On metal framing or studs, approved duct tape shall be used to secure pig-ear fold and membrane. Where no backing is provided between the studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding 1/2 inch from upper edge. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it will be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Surfaces to be

solvent-welded shall be clean. Surfaces to be joined with xylene shall be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 40 degrees F the membrane and the joint shall be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane shall be pressed into position on the drain body, and shall be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided.

#### 3.3.10.3 Nonplasticized Polyvinyl Chloride (PVC) Shower Pans

Nonplasticized PVC shall be turned up behind walls or wall surfaces a distance of not less than 6 inches in room areas and 3 inches above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of curb. Corners shall be pig-ear type and folded between pan and studs. Only top 1 inch of upstand shall be nailed to hold in place. Nails shall be galvanized large-head roofing type. Approved duct tape shall be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding at top inch of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Trim for drain shall be exactly the size of drain opening. Bolt holes shall be pierced to accommodate bolts with a tight fit. Adhesive shall be used between pan and subdrain. Clamping ring shall be bolted firmly. A small amount of gravel or porous materials shall be placed at weepholes so that holes remain clear when setting bed is poured. Membrane shall be solvent welded with PVC solvent cement. Surfaces to be solvent welded shall be clean (free of grease and grime). Sheets shall be laid on a flat surface with an overlap of about 2 inches. Top edge shall be folded back and surface primed with a PVC primer. PVC cement shall be applied and surfaces immediately placed together, while still wet. Joint shall be lightly rolled with a paint roller, then as the joint sets shall be rolled firmly but not so hard as to distort the material. In long lengths, about 2 or 3 feet at a time shall be welded.

### 3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 20 percent of the lowest equipment rpm.

#### 3.4.1 Tank- or Skid-Mounted Compressors

Floor attachment shall be as recommended by compressor manufacturer. Compressors shall be mounted to resist seismic loads as specified in Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

### 3.5 IDENTIFICATION SYSTEMS

#### 3.5.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

#### 3.5.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 3.6 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

### 3.7 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTS AND COATINGS.

### 3.8 TESTS, FLUSHING AND DISINFECTION

#### 3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC, except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the Contracting Officer for approval.

- a. Drainage and Vent Systems Test. The final test shall include a smoke test.
- b. Building Sewers Tests.
- c. Water Supply Systems Tests.

##### 3.8.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum,



the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of
Gauges	

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

#### 3.8.1.2 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 1 inch for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

#### 3.8.1.3 Compressed Air Piping (Nonoil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 150 psig and hold this pressure for 2 hours with no drop in pressure.

#### 3.8.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

#### 3.8.3 System Flushing

##### 3.8.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

### 3.8.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

### 3.8.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.
- i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.
- j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

### 3.8.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Except as herein specified, water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. The chlorinating material shall be fed into the

water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied.

The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.9 PLUMBING FIXTURE SCHEDULE

#### P9050 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - ANSI Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.6 gallons per flush. Valve shall be high mount approximately 42 inches above finish floor and shall include wall support bracket.

#### P9050HC WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with ICC A117.1; other features are the same as P9050. Valve mounting height shall be standard.

#### P8150 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P9050. The maximum water use shall be 1 gallon per flush.

P3070 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, countertop, oval, approximately 20 inches x 17 inches, self-rimming.

Faucet - Faucets shall meet the requirements of NSF 61, Section 9. Faucets shall be center set type. Faucets shall have replaceable seats and washers. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece

P3000 WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 20 inches wide x 18 inches deep with gooseneck spout. The flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Drain - Strainer shall be copper alloy or stainless steel.

P6150 UTILITY SINK:

Ledge back with holes for faucet and spout single bowl 24 x 24 inches stainless steel ASME A112.19.3 Provide mounting legs and support assembly for floor mounting.

Faucet and Spout - Faucets and spout shall be exposed ledge mounted and shall meet the requirements of NSF 61, Section 9. Cast or wrought copper alloy. The flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi. The faucet shall be provided with a hose end, vacuum breaker, and integral stops.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P4700 MOP RECEPTOR:

Molded stone with stainless steel edge guard 36 inches wide x 24 inches deep x 12 inches high, corner, floor mounted. Drain shall be cast brass with stainless steel strainer cast in the unit.

Faucet and Spout - Cast or wrought copper alloy, with top brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. The faucet shall be provided with a hose end and shall be provided with integral stops.

P5100 Shower: Shower heads, ASME A112.18.1 shall be adjustable spray type and shall include a non-removable, tamperproof device to limit water flow to 2.5 gpm when tested in accordance with ASME A112.18.1.

Wall Mounted: Shower head shall be adjustable spray, stainless steel or chromium plated brass with ball joint. Handles shall be chrome-plated die cast zinc alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be thermostatic mixing type with integral stops. Shower head shall be vandalproof with integral back.

P5100M Wall Mounted Three-Station Shower: The unit shall be furnished in a pre-piped 16 gauge stainless steel enclosure. All internal piping shall be copper tubing with bronze or wrought copper fittings. The unit valves, shower heads and accessories shall be the same as those indicated for P5100 hereinbefore.

CS-140 CS Sink: Countertop, self-rimming, 18 gage Type 304 stainless steel, ledge back, 16 x 13 inch overall size with 10 x 10 x 7 inch deep bowl. Faucet shall be chrome plated, single hole, deck mounted, gooseneck with lever handles. Gooseneck shall be 6-1/2 inches high with swivel feature. Flow shall be limited to 2.5 gallons/minute. Provide 1-1/2 inch outlet stainless steel crumb cup strainer with removable basket. Provide chrome plated supplies with stops, P-trap and waste extension. Provide C.P. escutcheons at pipe penetrations at wall.

PX100 Washing Machine Box: The unit may be either steel or PVC. The unit shall be recessed in the wall and shall be provided with a 2 inch drain and a hot and cold water hose valve. The assembly shall be designed so that any leaks from the valves or overflow will be contained within the unit and shall drain into the drain fitting. The unit rough opening size shall be approximately 13 inches wide x 8 inches high x 3-1/2 inches deep.

#### R-2202 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall meet the requirements of NSF 61, Section 9, shall be self contained, conform to ARI 1010, and use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05. Shall deliver not less than 8 gph of water at 50 degrees F with an inlet water temperature of 80 degrees F and ambient air temperature of 90 degrees F. Drinking fountains shall have a self-closing valve with automatic stream regulator, flow control capability, an in-line inlet strainer, and have push-button or bar actuation. Exposed surfaces of stainless steel shall have a satin finish. Waste strainers shall be made of chrome plated brass or stainless steel.

Surface wall-mounted units shall have a bowl and splash back made of stainless steel. The unit shall have concealed fasteners and be for interior installation.

R-2201 shall be same as R-2202 above except for two level units with the handicapped unit mounted at the lower level as follows: Handicapped units shall be surface wall-mounted. The unit shall clear the floor or ground by at least 8 inches. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 27 inches and between the front edge of the bowl and the body of the unit of at least 8 inches. An 8 inch wide clear space shall exist on both sides of the unit. The spout height shall be no more than 36 inches above the floor or ground. The

spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl and splash back shall be made of stainless steel and be for interior installation.

### 3.10 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

### 3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).

SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

#### 3.11.1 Storage Water Heaters

##### 3.11.1.1 Gas

- a. Storage capacity of more than 100 gallons - or input rating more than 75,000 Btu/h: Et shall be 77 percent; maximum SL shall be  $1.3 + 38/V$ , per ANSI Z21.10.3.

## 3.12 TABLES

TABLE I  
PIPE AND FITTING MATERIALS FOR  
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE			
Item #	Pipe and Fitting Materials	A	B	C	D
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47/A 47M	X	X		X
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M for use with Item 5	X	X		X
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5	X	X		X
8	Wrought copper grooved joint pressure fittings for non-ferrous pipe ASTM B 75 C12200, ASTM B 152/B 152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X		
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X
10	Steel pipe, seamless galvanized, ASTM A 53/A 53M, Type S, Grade B	X			X
11	Seamless red brass pipe, ASTM B 43		X		

TABLE I  
PIPE AND FITTING MATERIALS FOR  
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE			
Item #	Pipe and Fitting Materials	A	B	C	D
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X
14	Seamless copper pipe, ASTM B 42				
15	Cast bronze threaded fittings, ASME B16.15				X
16	Copper drainage tube, (DWV),	X*	X	X*	X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	X	X	X	X
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40) ASTM F 1760	X	X	X	X

## SERVICE:

- A - Underground Building Soil, Waste and Storm Drain
- B - Aboveground Soil, Waste, Drain In Buildings
- C - Underground Vent
- D - Aboveground Vent
- E - Interior Rainwater Conductors Aboveground
- F - Corrosive Waste And Vent Above And Belowground
- \* - Hard Temper



TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X	X
	b. Same as "a" but not galvanized for use with Item 4b			X	
2	Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47/A 47M, non-ferrous pipe, ASTM A 536 and ASTM A 47/A 47M,	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M, for use with Item 2	X	X	X	
4	Steel pipe: a. Seamless, galvanized, ASTM A 53/A 53M, Type S, Grade B	X	X	X	X
	b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B			X	
5	Seamless red brass pipe, ASTM B 43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		X
7	Seamless copper pipe, ASTM B 42	X	X		X
8	Seamless copper water tube, ASTM B 88, ASTM B 88M	X**	X**	X**	X***
9	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8	X	X	X	X
11	Cast copper alloy solder-joint pressure fittings,	X	X	X	X

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
	ASME B16.18 for use with Item 8				
12	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2	X	X	X	
13	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
14	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
15	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
16	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261 for use with Items 14, 15, and 16	X			X
17	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 15	X			X
18	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
19	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846/D 2846M	X	X		X
20	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F 441/F 441M	X	X		X
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442/F 442M	X	X		X
22	Threaded chlorinated polyvinyl chloride (chloride CPVC) plastic pipe fittings,	X	X		X

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
	Schedule 80, ASTM F 437, for use with Items 20, and 21				
23	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438 for use with Items 20, 21, and 22	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use with Items 20, 21, and 22	X	X		X
25	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
26	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
27	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X
28	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 26 and 27	X			X
29	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
30	Joints for IPS pvs pipe using solvent cement, ASTM D 2672	X			X
31	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996	X	X		
32	Steel pipeline flanges, MSS SP-44	X	X		
33	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X		
34	Carbon steel pipe unions,	X	X	X	

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
	socket-welding and threaded, MSS SP-83				
35	Malleable-iron threaded pipe unions ASME B16.39	X	X		
36	Nipples, pipe threaded ASTM A 733	X	X	X	
37	Crosslinked Polyethylene (PEX) Plastic Pipe ASTM F 877.	X			X

A - Cold Water Service Aboveground

B - Hot and Cold Water Distribution 180 degrees F Maximum Aboveground

C - Compressed Air Lubricated

D - Cold Water Service Belowground

Indicated types are minimum wall thicknesses.

\*\* - Type L - Hard

\*\*\* - Type K - Hard temper with brazed joints only or type K-soft  
temper without joints in or under floors

\*\*\*\* - In or under slab floors only brazed joints

TABLE III  
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING  
EQUIPMENT

## A. STORAGE WATER HEATERS

FUEL	STORAGE CAPACITY GALLONS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Gas	100 min. OR	75,000 Btu/h	ANSI Z21.10.3	ET = 77 percent; SL = $1.3+38/V$ max.
Gas	All	ANSI Z21.56	ET = 78 percent	

## TERMS:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0  
(trace is permitted).SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in  
percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area

V = Storage volume in gallons

-- End of Section --

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## DIVISION 15 - MECHANICAL

## SECTION 15569A

## WATER HEATING; GAS; UP TO 20 MBTUH

02/03

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## SECTION 15569A

WATER HEATING; GAS; UP TO 20 MBTUH  
02/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13 (2001; A 2002) Gas-Fired Low-Pressure  
Steam and Hot Water Boilers

## ASME INTERNATIONAL (ASME)

ASME BPVC SEC IV (2001) Boiler and Pressure Vessel Code;  
Section IV, Rules for construction of  
Heating Boilers

ASME CSD-1 (2002) Controls and Safety Devices for  
Automatically Fired Boilers

## HYDRONICS INSTITUTE DIVISION OF GAMA (HYI)

HYI Ratings (2002) I=B=R Ratings for Boilers,  
Baseboard Radiation and Finned Tube  
(Commercial)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (1999) National Fuel Gas Code

## UNDERWRITERS LABORATORIES (UL)

UL 795 (1999) Commercial-Industrial Gas Heating  
Equipment

UL Gas&Oil Dir (2000) Gas and Oil Equipment Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section



## 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Installation

Detail drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

## SD-03 Product Data

## Materials and Equipment; G, AE

Manufacturer's catalog data shall be included with the detail drawings for the following items:

Boilers  
Unit Heaters  
Boiler Stack Fan  
Pumps  
Fittings and Accessories

The data shall show model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements.

## Spare Parts

Spare parts data for each different item of material and equipment specified.

## Water Treatment System; G, RE

Six complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in paragraph BOILER WATER TREATMENT, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

## Heating System Tests; G, RE

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

## Qualifications; G, RE

A statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section.

Field Instructions; G, RE

System layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

Tests; G, RE

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

#### SD-06 Test Reports

Heating System Tests; G, RE

Fuel System Tests; G, RE

Test reports for the heating system tests, upon completion of testing complete with results.

Water Treatment Testing; G, RE

a. The water quality test report shall identify the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report.

b. A test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions.

#### SD-07 Certificates

Continuous Emissions Monitoring; G, RE

Written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Instructions; G, RE

Six complete manuals listing step-by-step procedures required

for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

### 1.3 GENERAL REQUIREMENTS

#### 1.3.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

#### 1.3.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

#### 1.3.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Each pressure vessel shall have an approved ASME stamp.

#### 1.3.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500A MISCELLANEOUS METAL.

#### 1.3.5 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

#### 1.3.6 Related Sections

See Section 15181A CHILLED AND HOT WATER PIPING AND ACCESSORIES for piping, equipment and accessories.

#### 1.3.7 Spare Parts

The Contractor shall submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit

prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

#### 1.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment.

#### 1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

### PART 2 PRODUCTS

#### 2.1 BOILERS

Each boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, natural draft/atmospheric burner or fan assisted draft, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPVC SEC IV. Each boiler shall be of the copper tube type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in HYI Ratings or as certified by the American Boiler Manufacturers Association, or American Gas Association.

##### 2.1.1 Watertube Boiler

The boiler shall be a standard, copper finned tube type of water tube boiler. Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base.

##### 2.1.2 Hot Water Heating Boilers

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions shall be as indicated on the drawings. See SD-07 "Certificates" for Continuous Emissions Monitoring.

- a. Boilers shall have an Annual Fuel Utilization Efficiency of at least 80 percent.

## 2.2 FUEL BURNING EQUIPMENT

Boiler shall be designed to burn gas. Each boiler shall comply with Federal, state, and local emission regulations.

### 2.2.1 Burners

#### 2.2.1.1 Gas Fired Burners and Controls

Burners shall be UL approved natural draft/atmospheric burners. Burner shall be provided complete with fuel supply system in conformance with the following safety codes or standards:

- a. Gas-fired units shall conform to UL 795 and ANSI Z21.13.

## 2.3 COMBUSTION CONTROL EQUIPMENT

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The boiler water temperature shall be controlled by a water temperature controller. The equipment shall operate electrically.

### 2.3.1 Electrical controls

Electrical control devices shall be rated at 120 or 24 volts and shall be connected as specified in Section 16415A ELECTRICAL WORK, INTERIOR.

### 2.3.2 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the boiler return piping. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent. Controller shall be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller shall be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.

### 2.3.3 Boiler Combustion Controls and Positioners

- a. Gas boiler units shall be provided with modulating combustion controls with spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.
- b. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller. Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

#### 2.3.4 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers shall be mounted on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Alarms shall be forwarded to the DDC system when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

- a. Flame failure.
- b. Failure to establish pilot flame.
- c. Failure to establish main flame.
- d. Low-water cutoff.
- e. High temperature cutoff.

##### 2.3.4.1 Low-water Cutoff

Low water cutoff shall be electrically actuated probe type low-water cutoff. Cutoff shall cause a safety shutdown and alarm the system when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall be in strict accordance to the latest version of code, ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers.

##### 2.3.4.2 Water Flow Interlock

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

#### 2.4 COLD WATER CONNECTIONS

Connections shall be provided which includes consecutively in line a strainer, backflow prevention device, and water pressure regulator in that order in the direction of the flow. The backflow prevention device shall be provided as indicated and in compliance with Section 15400A PLUMBING,

GENERAL PURPOSE. Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be set to maintain a terminal pressure of approximately, lately 5 psi in excess of the static head on the system and shall operate within a 2 psi tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

## 2.5 UNIT HEATERS

Heaters shall be as specified below, and shall have a heating capacity not in excess of 125 percent of the capacity indicated.

### 2.5.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for horizontal discharge of air as indicated. Casings shall be not less than 20 gauge black steel and finished with lacquer or enamel. Suitable stationary deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted.

### 2.5.2 Heating Elements

Heating coils and radiating fins shall be of suitable nonferrous alloy with threaded fittings at each end for connecting to external piping. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 200 psig and a certified report of the test shall be submitted to the Contracting Officer. Coils shall be suitable for use with water up to 250 degrees F.

### 2.5.3 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 16415A ELECTRICAL WORK, INTERIOR.

### 2.5.4 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

### 2.5.5 Controls

Controls shall be an electric wall-mounted 120 V thermostat with fan "on-off" switch.

## 2.6 AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.7 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in

accordance with ASME BPVC SEC IV, unless otherwise specified.

## 2.7.1 Conventional Breeching and Stacks

### 2.7.1.1 Stacks

Prefabricated double wall stacks system shall extend above the roof to the height indicated. The stack shall be Type "B" UL listed, double-wall vent.

The inner stack shall be aluminum having a thickness of not less than required by vent manufacturer. The outer stack shall be galvanized steel having a thickness of not less than required by vent manufacturer. A method of maintaining concentricity between the inner and outer stacks shall be incorporated. Each stack shall be provided complete with rain hood, roof stack support assembly, roof curb. The Headquarters Building shall be provided with a stack draft fan as hereinafter specified.

### 2.7.1.2 Stack Draft Fan System

- a. The unit shall be designed to operate with gas-fired appliances, with either atmospheric or fan assisted draft. The supplier shall provide calculations using the gas-fired appliances that are to be furnished. The lengths and sizes of the vents attached to the stack to verify proper draft. This information shall be furnished as a part of the shop drawing submittal. The drawings indicate air flows and static pressure requirements for estimating purposes only. The supplier shall verify the exact air flow and external static pressure required.
- b. The fan shall have the approximate capacities as indicated on the drawings and as indicated above. The fan shall be capable of handling flue gases up to 400 degrees F. measured at the flue exit point. The fan shall have a vertical discharge high velocity exit. The fan shall be ETL listed to UL 378 standard for draft equipment and ISO 9001 approved, and be designed for installation on the vent termination point where it can ensure a negative pressure in the entire stack system. The fan shall be constructed of cast aluminum or stainless steel. The fan motor shall be provided with thermal overload protection. The motor and wiring shall be designed for high temperatures.
- c. A system of operating controls shall be provided and installed and shall consist of the following: Modulating draft control with sensor and probe, 120 volt control board, chimney adaptor, balancing devices at each appliance. Factory start-up service shall be provided.

## 2.8 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Motors which are not an integral part of a packaged boiler shall be rated for high efficiency service. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices



required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

#### 2.8.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 hp and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

#### 2.8.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

#### 2.9 INSULATION

Shop and field-applied insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.10 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

#### 2.11 BOILER WATER TREATMENT

Shall be as specified in Section 15181A, CHILLED AND HOT WATER PIPING AND ACCESSORIES.

##### 2.11.1 Boiler Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

Causticity	20-200 ppm
Total Alkalinity (CAC03)	900-1200 ppm
Phosphate	30-60 ppm
Tanin	Medium
Dissolved Solids	3000-5000 ppm
Suspended Solids	300 ppm Max
Sodium Sulfite	20-40 ppm Max
Silica	Less than 150 ppm
Dissolved Oxygen	Less than 7 ppm
Iron	10 ppm
pH (Condensate)	7 - 8
Sodium Sulfite	20-40 ppm
Hardness	Less than 2 ppm

pH

9.3 - 9.9

### PART 3 EXECUTION

#### 3.1 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

#### 3.2 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15190A GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL Gas&Oil Dir. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

#### 3.3 HEATING SYSTEM TESTS

The Contractor shall submit the Qualifications of the firms in charge of installation and testing as specified in the Submittals paragraph. Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1-1/2 times the design working pressure, but not less than 100 psi. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested. Repair joints shall not be allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, the entire zone that is leaking shall be replaced. If any repair is made above the floor for floor radiant heating systems, access shall be provided for the installed joint. Caulking of joints shall not be permitted. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested. Upon completion of hydrostatic tests and before acceptance of the installation, the Contractor shall balance the heating system in accordance with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS; and operating tests required to demonstrate satisfactory functional and operational efficiency shall be performed. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to

the adequacy of the system:

- a. Certification of balancing.
- b. Time, date, and duration of test.
- c. Outside and inside dry bulb temperatures.
- d. Temperature of hot water supply leaving boiler.
- e. Temperature of heating return water from system at boiler inlet.
- f. Quantity of water feed to boiler.
- g. Boiler make, type, serial number, design pressure, and rated capacity.
- h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.
- i. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.
- j. Flue-gas temperature at boiler outlet.
- k. Percent carbon dioxide in flue-gas.
- l. Grade or type and calorific value of fuel.
- m. Draft at boiler flue-gas exit.
- n. Draft or pressure in furnace.
- o. Quantity of water circulated.
- p. Quantity of fuel consumed.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. The Contractor shall furnish all instruments, equipment, and personnel required for the tests and balancing. Fuels, water, and electricity shall be obtained as specified in the SPECIAL CONTRACT REQUIREMENTS. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1.

### 3.3.1 Water Treatment Testing

#### 3.3.1.1 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs shall be made by the water treatment company.

### 3.4 CLEANING

#### 3.4.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of either 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

#### 3.4.2 Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for fans that are operated during construction, and new filters shall be installed after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.5 FUEL SYSTEM TESTS

#### 3.5.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

### 3.6 FIELD TRAINING

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance instructions, as well as demonstrations of routine maintenance operations and boiler safety devices. The Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

-- End of Section --

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## SECTION 15620A

## LIQUID CHILLERS

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## SECTION 15620A

## LIQUID CHILLERS

**06/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 550/590 (1998) Water-Chilling Packages Using the Vapor Compression Cycle

ARI 700 (1999) Specifications for Fluorocarbon and Other Refrigerants

## AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11 (1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings

ABMA 9 (1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307 (2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM D 520 (2000) Zinc Dust Pigment

ASTM E 84 (2000a) Surface Burning Characteristics of Building Materials

ASTM F 104 (1995) Nonmetallic Gasket Materials

## AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 (1994) Safety Code for Mechanical Refrigeration

ASHRAE 34 (1997) Number Designation and Safety Classification of Refrigerants

## AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1 (1999) Safety in Welding and Cutting

## ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators
NEMA MG 2	(1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Installation

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Equipment layouts which identify assembly and installation details.
- b. Plans and elevations which identify clearances required for maintenance and operation.
- c. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.
- d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.
- e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

## SD-03 Product Data

## Refrigeration System; G, AE

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts



and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

- a. Liquid Chiller
- b. Chiller Components
- c. Accessories

If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

#### Posted Instructions

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

#### Verification of Dimensions; G, AE

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

#### Manufacturer's Multi-Year Compressor Warranty; G, AE

Manufacturer's multi-year warranty for compressor(s) in air-cooled liquid chillers as specified.

#### System Performance Tests; G, RE

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

#### Demonstrations; G, RE

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

#### SD-06 Test Reports

##### System Performance Tests; G, RE

Six copies of the report shall be provided in bound 8 1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the

system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

- a. Date and outside weather conditions.
- b. The load on the system based on the following:
  - (1) The refrigerant used in the system.
  - (2) Condensing temperature and pressure.
  - (3) Suction temperature and pressure.
  - (4) Running current, voltage and proper phase sequence for each phase of all motors.
  - (5) The actual on-site setting of all operating and safety controls.
  - (6) Chilled water pressure, flow and temperature in and out of the chiller.

#### SD-07 Certificates

##### Refrigeration System

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, 1 copy of proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

##### Service Organization; G, RE

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

#### SD-10 Operation and Maintenance Data

##### Operation Manuals; G, RE

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training

course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; G, RE

Six complete copies of maintenance manual in bound 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

### 1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

### 1.5 PROJECT/SITE CONDITIONS

#### 1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

#### 1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

### 1.6 MANUFACTURER'S MULTI-YEAR COMPRESSOR WARRANTY

The Contractor shall provide a 5 year parts only (excludes refrigerant) manufacturer's warranty on the air-cooled chiller compressor(s). This warranty shall be directly from the chiller manufacturer to the Government and shall be in addition to the standard one-year warranty of construction.

The manufacturer's warranty shall provide for the repair or replacement of the chiller compressor(s) that become inoperative as a result of defects in material or workmanship within 5 years after the date of final acceptance. When the manufacturer determines that a compressor requires replacement, the manufacturer shall furnish new compressor(s) at no additional cost to

the Government. Upon notification that a chiller compressor has failed under the terms of the warranty, the manufacturer shall respond in no more than 24 hours. Response shall mean having a manufacturer-qualified technician onsite to evaluate the extent of the needed repairs. The warranty period shall begin on the same date as final acceptance and shall continue for the full product warranty period.

#### 1.6.1 Indexed Notebook

The Contractor shall furnish to the Contracting Officer a bound and indexed notebook containing a complete listing of all air-cooled liquid chillers covered by a manufacturer's multi-year warranty. The chiller list shall state the duration of the warranty thereof, start date of the warranty, ending date of the warranty, location of the warranted equipment, and the point of contact for fulfillment of the warranty. Point of contact shall include the name of the service representative along with the day, night, weekend, and holiday phone numbers for a service call. The completed bound and indexed notebook shall be delivered to the Contracting Office prior to final acceptance of the facility.

#### 1.6.2 Local Service Representative

The Contractor shall furnish with each manufacturer's multi-year warranty the name, address, and telephone number (day, night, weekend, and holiday) of the service representative nearest to the location where the equipment is installed. Upon a request for service under the multi-year warranty, the service representative shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty.

#### 1.6.3 Equipment Warranty Tags

At the time of installation, each item of manufacturer's multi-year warranted equipment shall be tagged with a durable, oil- and water-resistant tag, suitable for interior and exterior locations, resistant to solvents, abrasion, and fading due to sunlight. The tag shall be attached with copper wire or a permanent, pressure-sensitive, adhesive backing. The tag shall be installed in an easily noticed location attached to the warranted equipment. The tag for this equipment shall be similar to the following in format, and shall contain all of the listed information:

##### MANUFACTURER'S MULTI-YEAR WARRANTY EQUIPMENT TAG

Equipment/Product Covered: \_\_\_\_\_

Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_ Serial No.: \_\_\_\_\_

Warranty Period: From \_\_\_\_\_ to \_\_\_\_\_

Contract No.: \_\_\_\_\_

Warranty Contact: \_\_\_\_\_

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: \_\_\_\_\_

STATION PERSONNEL SHALL PERFORM PREVENTIVE  
MAINTENANCE AND OPERATIONAL MAINTENANCE

## PART 2 PRODUCTS

### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a

similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

## 2.2 NAMEPLATES

Major equipment including chillers, compressors, compressor drivers, condensers, liquid coolers, receivers, refrigerant leak detectors, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

## 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 SELF-CONTAINED LIQUID CHILLER

Unless necessary for delivery purposes, units shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unless the condenser coil is completely protected through inherent design, louvered panel coil guards shall be provided by the manufacturer to prevent physical damage to the coil. Unit components

delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, shall have lifting eyes or lugs. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller shall be provided with a single point wiring connection for incoming power supply. Chiller's condenser and liquid cooler shall be provided with standard water boxes with flanged connections. Provide Operation Manuals and Maintenance Manuals as indicated in SD-10.

#### 2.4.1 Scroll, Reciprocating, or Rotary Screw Type

Chiller shall be constructed and rated in accordance with ARI 550/590. Chiller shall conform to ASHRAE 15. Chillers of 150 tons and smaller shall have a minimum full load EER rating of 9.5 and a part load kW/ton rating of 1.12 in accordance with ARI 550/590. Chiller of 150 tons and larger shall have a minimum full load EER rating of 9.2 and a part load kW/ton rating of 1.22 in accordance with ARI 550/590. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

- a. Refrigerant and oil
- b. Structural base
- c. Chiller refrigerant circuit
- d. Controls package
- e. Scroll, reciprocating, or rotary screw compressor
- f. Compressor driver, electric motor
- g. Compressor driver connection
- h. Liquid cooler (evaporator)
- i. Air-cooled condenser coil
- j. Receiver
- k. Tools

#### 2.5 CHILLER COMPONENTS

##### 2.5.1 Refrigerant and Oil

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.0.

### 2.5.2 Structural Base

Chiller and individual chiller components shall be provided with a factory-mounted structural steel base (welded or bolted) or support legs. Chiller and individual chiller components shall be isolated from the building structure by means of molded neoprene isolation pads.

### 2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit shall be completely piped and factory leak tested. For multicompressor units, not less than 2 independent refrigerant circuits shall be provided. Circuit shall include as a minimum a combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve for reciprocating, an electronic or thermostatic expansion valve with external equalizer, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

### 2.5.4 Controls Package

Chiller shall be provided with a complete factory-mounted, prewired electric or microprocessor based control system. Controls package shall contain as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, and control wiring. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below.

#### 2.5.4.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

- a. Leaving chilled water temperature control
- b. Adjustable timer or automated controls to prevent a compressor from short cycling
- c. Automatic lead/lag controls (adjustable) for multi-compressor units
- d. Load limiting
- e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.
- f. Startup and head pressure controls to allow system operation at all ambient temperatures down to zero degrees F
- g. Fan sequencing for air-cooled condenser

#### 2.5.4.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

- a. Entering and leaving chilled water temperatures
- b. Self diagnostic

- c. Operation status
- d. Operating hours
- e. Number of starts
- f. Compressor status (on or off)
- g. Refrigerant discharge and suction pressures
- h. Oil pressure

#### 2.5.4.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. The programmable setpoints shall include the following as a minimum.

- a. Leaving Chilled Water Temperature
- b. Time Clock/Calendar Date

#### 2.5.4.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

- a. Low chilled water temperature protection
- b. High condenser refrigerant discharge pressure protection
- c. Low evaporator pressure protection
- d. Chilled water flow detection
- e. High motor winding temperature protection
- f. Low oil flow protection if applicable
- g. Motor current overload and phase loss protection

#### 2.5.4.5 Safety Controls with Automatic Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

- a. Over/under voltage protection
- b. Chilled water flow interlock
- c. Phase reversal protection

#### 2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system shall be capable of sending alarms to the building DDC system. In coordination with the chiller, the contractor shall provide an alarm circuit (including transformer if applicable). Alarm circuit shall activate DDC system alarm in the event of machine shutdown due to the



chiller's monitoring of safety controls.

#### 2.5.4.7 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

- a. Remote Unit Start/Stop

#### 2.5.5 Compressor(s)

##### 2.5.5.1 Reciprocating Compressor(s)

Rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Compressors shall be capable of operating at partial-load conditions without increased vibration over the normal vibration at full load operation and shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of size 10 horsepower and above shall have an oil lubrication system of the reversible, forced-feed type with oil strainer. Shaft seal in open-type units shall be mechanical type. Piston speed for open-type compressors shall not exceed the manufacturer's recommendation or 1200 fpm, whichever is less. Compressors shall include:

- a. Vertical, V, W, or radial cylinder design
- b. Oil lubrication
- c. Integrally cast block of close-grained iron or cast aluminum block with hardened steel cylinder sleeves
- d. Oil-level bull's eye
- e. Cast cylinder heads
- f. Cast-aluminum or forged-steel connecting rods
- g. Cast iron or forged-steel crankshaft
- h. Main bearings of the sleeve-insert type
- i. Crankcase oil heaters controlled as recommended by the manufacturer
- j. Suction and discharge refrigerant service valves that are flange connected, wrench operated, with cap
- k. A strainer on the suction side of the compressor
- l. A hot-gas muffler to reduce vibration and noise from pulsations

##### 2.5.5.2 Scroll Compressor(s)

Compressors shall be of the hermetically sealed design. Compressors shall be mounted on vibration isolators to minimize vibration and noise. Rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Lubrication system shall be centrifugal pump type

equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater shall be provided if standard or if available as an option. If provided, the crankcase oil heater shall be controlled as recommended by the manufacturer.

#### 2.5.5.3 Rotary Screw Compressor(s)

Compressors shall operate stably for indefinite time periods at any stage of capacity reduction without hot-gas bypass. Provision shall be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors shall include:

- a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Compressor shall allow access to internal compressor components for repairs, inspection, and replacement of parts.
- b. Rotors which are solid steel forging with sufficient rigidity for proper operation.
- c. A maximum rotor operating speed no greater than 3600 RPM.
- d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors.
- e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.
- f. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Bearings shall be conservatively loaded and rated for an L(10) life of not less than 200,000 hours.
- g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.
- h. A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 15 percent.
- i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.
- j. Crankcase oil heaters controlled as recommended by the manufacturer.

#### 2.5.6 Compressor Driver, Electric Motor

Motors, starters, wiring, etc. shall be in accordance with paragraph ELECTRICAL WORK. Motor starter shall be unit mounted as indicated with starter type, wiring, and accessories coordinated with the chiller manufacturer. Starter shall be able to operate in temperatures up to 120 degrees F.

#### 2.5.7 Liquid Cooler (Evaporator)

Cooler shall be of the shell-and-coil or shell-and-tube type design.

Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than 150 psi. Cooler shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on a water velocity not less than 3 fps nor more than 12 fps and a fouling factor of  $0.0001 \text{ h}(\text{ft}^2)(\text{degrees F})/\text{Btu}$ .

#### 2.5.8 Air-Cooled Condenser Coil

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless copper tubes with compatible aluminum fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15.

#### 2.5.9 Tools

One complete set of special tools, as recommended by the manufacturer for field maintenance of the system, shall be provided. Tools shall be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

### 2.6 ACCESSORIES

#### 2.6.1 Refrigerant Signs

##### 2.6.1.1 Installation Identification

Each new refrigerating system shall be provided with a refrigerant sign which indicates the following as a minimum:

- a. Contractor's name.
- b. Refrigerant number and amount of refrigerant.
- c. The lubricant identity and amount.
- d. Field test pressure applied.

#### 2.6.2 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

#### 2.6.3 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

## 2.7 FABRICATION

### 2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

### 2.7.2 Factory Applied Insulation

Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the liquid cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it shall be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

## 2.8 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.8.1 Chilled Water Piping and Accessories

Chilled and condenser water piping and accessories shall be provided and installed in accordance with Section 15181A CHILLED AND CONDENSER WATER PIPING AND ACCESSORIES.

### 2.8.2 Temperature Controls

Chiller control packages shall be fully coordinated with and integrated into the temperature control system specified in Section 15951A DIRECT DIGITAL CONTROL FOR HVAC.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where

equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

### 3.1.1 Refrigeration System

#### 3.1.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, liquid coolers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to 40 percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

#### 3.1.1.2 Field Refrigerant Charging

- a. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.
- b. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

#### 3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

#### 3.1.2 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

#### 3.1.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTS AND COATINGS.

### 3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 2 days. The representative shall advise on the following:

#### a. Hermetic machines:

- (1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.
- (2) Charging the machine with refrigerant.
- (3) Starting the machine.

### 3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

### 3.4 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to

acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

### 3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

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## SECTION 15700A

UNITARY HEATING AND COOLING EQUIPMENT  
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## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 210/240	(1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 460	(2000) Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ARI 500	(2000) Variable Capacity Positive Displacement Refrigerant Compressors and Compressor Units for Air-Conditioning and Heat Pump Applications
ARI 700	(1999) Specifications for Fluorocarbon and Other Refrigerants

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(2000) Zinc Dust Pigment
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials

## AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1997) Number Designation and Safety Classification of Refrigerants
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for

## Removing Particulate Matter

## AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1 (1999) Safety in Welding and Cutting

## ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX (1998) Boiler and Pressure Vessel Code;  
Section IX, Welding and Brazing  
Qualifications

ASME BPVC SEC VIII D1 (1998) Boiler and Pressure Vessel Code;  
Section VIII, Pressure Vessels Division 1  
- Basic Coverage

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6 (1993) Industrial Control and Systems,  
Enclosures

NEMA MG 1 (1998) Motors and Generators

NEMA MG 2 (1989) Safety Standard for Construction  
and Guide for Selection, Installation, and  
Use of Electric Motors and Generators

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 1995 (1995; Rev thru Aug 1999) Heating and  
Cooling Equipment

UL 900 (1994; Rev thru Nov 1999) Test Performance  
of Air Filter Units

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Drawings; G, RE

Drawings provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

#### SD-03 Product Data

Unitary Equipment; G, AE

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

Posted Instructions

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

System Performance Tests; G, RE

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations; G, RE

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

#### SD-06 Test Reports

## Refrigerant Tests, Charging, and Start-Up; G, RE

Six copies of each test containing the information described below in bound 8-1/2 x 11 inch booklets. Individual reports shall be submitted for the refrigerant system tests.

- a. The date the tests were performed.
- b. A list of equipment used, with calibration certifications.
- c. Initial test summaries.
- d. Repairs/adjustments performed.
- e. Final test results.

## System Performance Tests; G, RE

Six copies of the report provided in bound 8-1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

- a. Date and outside weather conditions.
- b. The load on the system based on the following:
  - (1) The refrigerant used in the system.
  - (2) Condensing temperature and pressure.
  - (3) Suction temperature and pressure.
  - (4) Ambient, condensing and coolant temperatures.
  - (5) Running current, voltage and proper phase sequence for each phase of all motors.
- c. The actual on-site setting of operating and safety controls.
- d. Thermostatic expansion valve superheat - value as determined by field test.
- e. Subcooling.
- f. High and low refrigerant temperature switch set-points
- g. Low oil pressure switch set-point.
- h. Defrost system timer and thermostat set-points.
- i. Moisture content.
- j. Capacity control set-points.
- k. Field data and adjustments which affect unit performance and energy consumption.

1. Field adjustments and settings which were not permanently marked as an integral part of a device.

#### SD-07 Certificates

##### Unitary Equipment

Where the system, components, or equipment are specified to comply with requirements of ARI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

##### Service Organization

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

#### SD-10 Operation and Maintenance Data

##### Operation Manuals; G, RE

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

##### Maintenance Manuals; G, RE

Six complete copies of maintenance manual in bound 8-1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

### 1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to

operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

#### 1.5 PROJECT/SITE CONDITIONS

##### 1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

##### 1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

### PART 2 PRODUCTS

#### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

#### 2.2 NAMEPLATES

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

## 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 UNITARY EQUIPMENT, PACKAGE SYSTEM

Unit shall be an air-cooled factory assembled, indoor packaged unit as indicated. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ARI 210/240. Unit shall be provided with equipment as specified in paragraph "Unitary Equipment Components". Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Motors shall have dripproof enclosures. Condenser fans shall be manufacturer's standard for ducted inlet and outlet condenser air and may be either propeller or centrifugal scroll type. Unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge.

Unit shipped with a holding charge shall be field charged with refrigerant and oil in accordance with manufacturer's recommendations. The unit shall be designed for ducted inlet and outlet condenser air. Provide Operation Manuals and Maintenance Manuals in accordance with SD-10 requirements.

### 2.4.1 Air-to-Refrigerant Coils

Air-to-refrigerant coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged.

Separate expansion devices shall be provided for each compressor circuit.



#### 2.4.2 Compressor

Compressor shall be direct drive, scroll type. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors shall operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Compressors shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, high and low pressure safety cutoffs and protection against short cycling.

#### 2.4.3 Refrigeration Circuit

Refrigerant containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve.

#### 2.4.4 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure, and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 35 degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995.

#### 2.5 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled, split system which employs a remote condensing unit, a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ARI 210/240. Unit shall be provided with necessary fans, air filters, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSING UNIT. Evaporator or supply fans shall be double-width, double inlet, forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have dripproof enclosures.

##### 2.5.1 Air-to-Refrigerant Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance

with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge.

Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

#### 2.5.2 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure, and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 35 degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

#### 2.6 REMOTE CONDENSING UNIT

Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of 35 degrees F. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have drip-proof enclosures.

##### 2.6.1 Air-Cooled Condenser

Unit shall be rated in accordance with ARI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

##### 2.6.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condensing unit and evaporator units shall be provided.

##### 2.6.1.2 Head Pressure Control and Liquid Subcooling

Low ambient control for multi-circuited units serving more than one evaporator coil shall provide independent condenser pressure controls for each refrigerant circuit. Controls shall be set to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Unit shall be provided with a liquid subcooling circuit which shall ensure proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit shall be provided with manufacturer's standard liquid subcooling. Subcooling circuit shall be liquid sealed.

#### 2.6.1.3 Condensing Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

#### 2.6.1.4 Unit Controls

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, fan motor starters, time delay start-up, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

#### 2.6.2 Compressor

Unit shall be rated in accordance with ARI 500. Compressor shall be direct drive, scroll type. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs and protection against short cycling.

#### 2.7 EQUIPMENT EFFICIENCY

Unit shall have an efficiency as indicated on the drawings.

#### 2.8 UNITARY EQUIPMENT COMPONENTS

##### 2.8.1 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Contractor shall provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the system performance testing period. Following the satisfactory completion of the performance testing, the oil shall be drained and replaced with a second charge. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

##### 2.8.2 Air Filters

Air filters shall be listed in accordance with requirements of UL 900.

#### 2.8.2.1 Replaceable Media Filters

Replaceable media filters shall be the dry-media type, of the size required to suit the application. Filtering media shall be not less than 1 inch thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame. The air flow capacity of the filter shall be based on net filter face velocity not exceeding 300 feet per minute, with initial resistance of 0.13 inches water gauge. Average efficiency shall be not less than 25 percent when tested in accordance with ASHRAE 52.1.

#### 2.8.3 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

##### 2.8.3.1 Indoor Cabinet

Indoor cabinets shall be suitable for the specified indoor service and enclose all unit components.

##### 2.8.3.2 Outdoor Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

#### 2.9 ACCESSORIES

##### 2.9.1 Refrigerant Signs

###### 2.9.1.1 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

- a. Contractor's name
- b. Refrigerant number and amount of refrigerant.
- c. The lubricant identity and amount.
- d. Field test pressure applied.

#### 2.9.2 Bird Screen

Screen shall be in accordance with ASTM E 437, Type 1, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

#### 2.10 FABRICATION

##### 2.10.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

##### 2.10.2 Factory Applied Insulation

Refrigeration equipment shall be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

#### 2.11 SUPPLEMENTAL COMPONENTS/SERVICES

##### 2.11.1 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Section 15182 REFRIGERANT PIPING.

### 2.11.2 Ductwork

Ductwork shall be provided and installed in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

### 2.11.3 Temperature Controls

Temperature controls shall be in accordance with Section 15951A DIRECT DIGITAL CONTROLS FOR HVAC.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

#### 3.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to 20 percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

#### 3.1.2 Field Applied Insulation

Field applied insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

#### 3.1.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

### 3.2 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

### 3.3 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified in Section 15182 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels per manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

#### 3.3.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

#### 3.3.2 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim.

At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

### 3.4 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be

installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

### 3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --



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## DIVISION 15 - MECHANICAL

## SECTION 15895

## AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

02/03

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## SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM  
**02/03**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 260	(2001) Sound Rating of Ducted Air Moving and Conditioning Equipment
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1999) Central-Station Air-Handling Units
ARI 440	(1998) Room Fan-Coils
ARI 880	(1998) Air Terminals
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1999) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

## AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings

## ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123/A 123M	(2001a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 924/A 924M	(1999) General Requirements for Steel

Sheet, Metallic-Coated by the Hot-Dip  
Process

ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 1071	(2000) Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D 520	(2000) Zinc Dust Pigment
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power in a Duct
ASHRAE 70	(1991) Method of Testing for Rating the Performance of Air Outlets and Inlets

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1419	(Rev D; Canc. Notice 1) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems
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SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION  
(SMACNA)

SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997; 6th Printing 2001) HVAC Duct Construction Standards - Metal and Flexible
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SMACNA Install Fire Damp HVAC	(1992; 2th Printing 1996) Fire, Smoke and
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Radiation Damper Installation Guide for  
HVAC SystemsSMACNA Leakage Test Mnl (1985; 6th Printing 1997) HVAC Air Duct  
Leakage Test Manual

## UNDERWRITERS LABORATORIES (UL)

UL 181 (1996; Rev thru Dec 1998) Factory-Made Air  
Ducts and Air Connectors

UL 214 (1997; Rev thru Aug 2001) Tests for  
Flame-Propagation of Fabrics and Films

UL 555 (1999; Rev thru Jan 2002) Fire Dampers

UL 586 (1996; Rev thru Apr 2000) High-Efficiency,  
Particulate, Air Filter Units

UL 900 (1994; Rev thru Oct 1999) Air Filter Units

UL 1995 (1995; Rev thru Aug 1999) Heating and  
Cooling Equipment

UL Bld Mat Dir (1999) Building Materials Directory

UL Fire Resist Dir (2001) Fire Resistance Directory (2 Vol.)

## 1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

## 1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

## 1.4 FIELD MEASUREMENTS

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings

## Installation

Drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

## SD-03 Product Data

### Components and Equipment; G, AE

Manufacturer's catalog data included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

- a. Piping Components
- b. Ductwork Components
- c. Air Systems Equipment
- d. Air Handling Units
- e. Terminal Units

### Test Procedure; G, RE

Proposed test procedures for ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

### Welding Procedures; G, RE

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

### Diagrams; G, RE

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

### Manufacturer's Experience; G, RE

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welded Joints; G, RE

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Performance Tests; G, RE

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training; G, RE

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

#### SD-06 Test Reports

Performance Tests; G, RE

Testing, Adjusting, and Balancing; G, AE

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

#### SD-07 Certificates

Bolts

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

#### SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, RE

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year manufacturer's experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. Provide manufacturer's experience record in accordance with SD-03 Submittal Data.

### 2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

### 2.3 NAMEPLATES

Equipment shall have a nameplate installed by the manufacturer that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

### 2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Miscellaneous metal shall be provided where shown and shall be constructed according to Section 05500A MISCELLANEOUS METAL.

### 2.5 PIPING

Piping and accessories shall be as specified in Section 15181A CHILLED AND HOT WATER PIPING AND ACCESSORIES. Provide welding procedures and procedures for welded joints as indicated in SD-03.

#### 2.5.1 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400A PLUMBING, GENERAL PURPOSE.

### 2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415A ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be



provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

## 2.7 CONTROLS

Controls shall be provided as specified in Section 15951A DIRECT DIGITAL CONTROLS FOR HVAC.

## 2.8 DUCTWORK COMPONENTS

### 2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. 3 through 10 inch w. g. shall meet the requirements of Seal Class A. All ductwork in VAV systems upstream of the VAV boxes shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS and shall be suitable for the range of air distribution and ambient temperatures that it will be exposed to. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

#### 2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

#### 2.8.1.2 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length

shall be as shown on the drawings, but shall in no case exceed 5 feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

#### 2.8.1.3 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans, where ducts of dissimilar metals are connected and at other locations as indicated on the Drawings. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

#### 2.8.2 Ductwork Accessories

##### 2.8.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring stations, automatic dampers, fire dampers, coils, duct thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

##### 2.8.2.2 Fire Dampers

Fire dampers shall be 1.5 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. The Contractor shall perform the fire damper test as outlined in NFPA 90A. A pressure relief damper shall be provided upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then this pressure relief damper shall be factory insulated. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be curtain type with damper blades out of the air stream multi-blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall,

partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed. Acceptance testing of fire dampers shall be performed per paragraph Fire Damper Acceptance Test and NFPA 90A.

#### 2.8.2.3 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing.

Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

#### 2.8.2.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections shall be used in lieu of deflectors or extractors for branch connection where possible. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air double-wall type deflectors, also called turning vanes, shall be provided in 90 degree elbows.

#### 2.8.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

##### 2.8.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or

less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53/A 53M, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

#### 2.8.3.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

#### 2.8.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

#### 2.8.4 Plenums and Casings

##### 2.8.4.1 Plenum and Casings

Plenums and casings shall be fabricated and erected as shown in SMACNA HVAC Duct Const Stds, as applicable. Unless otherwise indicated, system casing shall be constructed of not less than 16 gauge galvanized sheet steel.

#### 2.8.5 Sound Attenuation Duct

Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system shall be provided where indicated. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 2 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified.

- a. Acoustical Duct Liner: Acoustical duct liner will not be allowed.

#### 2.8.6 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers.

##### 2.8.6.1 Diffusers

Diffuser types shall be as indicated on the drawings. Ceiling mounted units shall be furnished with concentric ring air deflectors. Diffusers utilizing a preformed face panel will not be acceptable. Ceiling mounted units shall be installed with rims tight against ceiling or installed in T-bar ceiling support system. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller.

##### 2.8.6.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Wall-mounted return and exhaust registers shall be located 6 inches below the ceiling unless otherwise indicated. Ceiling mounted registers and grilles shall be installed with flange flush with the finished ceiling. Grilles shall be as specified for registers, without volume control damper.

##### 2.8.7 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 10201N METAL WALL LOUVERS.

##### 2.8.8 Air Vents and Goosenecks

Air vents and goosenecks shall be fabricated from galvanized steel or aluminum sheets with galvanized or aluminum structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA HVAC Duct Const Stds. Air vents and goosenecks shall be provided with bird screen.

##### 2.8.9 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum or stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

## 2.9 AIR SYSTEMS EQUIPMENT

### 2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts.

Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated. Each fan shall be provided with a disconnect switch. Disconnect switch may be either field or factory mounted.

#### 2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved or backward-inclined airfoil design in wheel sizes up to 30 inches. Fan blades for wheels over 30 inches in diameter shall be backward-inclined airfoil design. Booster fans for exhaust dryer systems shall be the open-wheel radial type. These fans shall be suitable for conveying lint and the temperatures encountered. The fan shaft shall be provided with a heat slinger to dissipate heat buildup along the shaft. An access (service) door to facilitate maintenance shall be supplied with these fans. Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have drip-proof enclosures. Motor starters shall be magnetic across-the-line type with general-purpose enclosure. Remote manual switch with pilot indicating light shall be provided where indicated.

#### 2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts or direct drive type as indicated. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Motors shall have dripproof enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosures. Remote manual switch with pilot indicating light shall be provided where indicated.

#### 2.9.1.3 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches in diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be dripproof type. Motor operated backdraft dampers shall be provided where indicated.

#### 2.9.1.4 Centrifugal Type Power Wall Ventilators

Fans shall be direct or V-belt driven centrifugal type with backward inclined, non-overloading wheel. Motor housing shall be removable and weatherproof. Unit housing shall be designed for sealing to building surface and for discharge and condensate drippage away from building surface. Housing shall be constructed of heavy gauge aluminum. Unit shall be fitted with an aluminum or plated steel wire discharge bird screen, manufacturer's standard motor-operated damper, an airtight and liquid-tight metallic wall sleeve. Motor enclosure shall be totally enclosed fan cooled type. Lubricated bearings shall be provided.

#### 2.9.1.5 Centrifugal Type Power Roof Ventilators

Fans shall be direct or V-belt driven with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with birdscreen, disconnect switch, motorized dampers, roof curb designed specifically for metal roofs, and extended base. Motors enclosure shall be dripproof type. Lubricated bearings shall be provided.

#### 2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper tubes and aluminum fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.016 inches. Aluminum fins shall be 0.0055 inch minimum thickness. Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 psi air pressure and shall be suitable for 200 psi

working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

#### 2.9.2.1 Direct-Expansion Coils

Direct-expansion coils shall be suitable for the refrigerant involved. Suction headers shall be seamless copper tubing or resistance welded steel tube with copper connections. Supply headers shall consist of a distributor which shall distribute the refrigerant through seamless copper tubing equally to all circuits in the coil. Tubes shall be circuited to ensure minimum pressure drop and maximum heat transfer. Circuiting shall permit refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Each coil to be field installed shall be completely dehydrated and sealed at the factory upon completion of pressure tests.

#### 2.9.2.2 Water Coils

Water coils shall be installed with a pitch of not less than 1/8 inch per foot of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

#### 2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

##### 2.9.3.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

##### 2.9.3.2 Holding Frames

Frames shall be fabricated from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

##### 2.9.3.3 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, shall have white dials with black figures, and shall be graduated in 0.01 inch, and shall have a minimum range of 1 inch beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure taps with integral compression fittings, two molded plastic



vent valves, two 5 foot minimum lengths of 1/4 inch diameter vinyl tubing, and all hardware and accessories for gauge mounting.

## 2.10 AIR HANDLING UNITS

### 2.10.1 Factory-Fabricated Air Handling Units

Units shall be single-zone draw-through of modular construction type as indicated. Units shall include fans mounted internally on a vibration isolation base, coils, airtight insulated casing, prefilters, access sections where indicated, combination sectional filter-mixing box where indicated, internal vibration-isolators, and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

#### 2.10.1.1 Casings

Casing sections shall be 2 inch double wall type as indicated, constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. Inner casing of double-wall units shall be minimum 20 gauge solid galvanized steel. Casing shall be designed and constructed with an integral insulated structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 18 gauge outer and 20 gauge inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 12 inches wide by 12 inches high. Access doors shall be minimum 24 inches wide and shall be the full height of the unit casing or a minimum of 6 foot, whichever is less. Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-wall insulated type constructed of 16 gauge stainless steel, pitched to the drain connection. Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Drain pan shall be constructed so that the pan may be visually inspected easily including underneath the coil without removal of the coil and so that the pan may be physically cleaned completely and easily underneath the coil without removal of the coil. Casing insulation shall conform to NFPA 90A. Double-wall casing sections handling conditioned air shall be insulated with not less than 2 inches of 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Foil-faced insulation shall not be an acceptable substitute for use with double wall casing. Double wall insulation must be completely sealed by inner and outer panels. Factory applied fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Air handling unit casing insulation shall be uniform over the entire casing. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors. A latched and hinged inspection door, shall be provided in the fan

and coil sections. Additional inspection doors, access doors and access sections shall be provided where indicated.

#### 2.10.1.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

#### 2.10.1.3 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

#### 2.10.1.4 Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit.

Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing.

Bearings may not be fastened directly to the unit sheet metal casing.

Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted motor connected to fans by V-belt drive. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have splashproof enclosures. Motor starters for constant volume units shall be magnetic across-the-line type with general-purpose enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300, ASHRAE 68, or ARI 260. Variable frequency drives shall be provided for all variable volume air handling units.

#### 2.10.1.5 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

#### 2.10.1.6 Dampers

Dampers shall be as specified in paragraph CONTROLS.

### 2.11 TERMINAL UNITS

#### 2.11.1 Room Fan-Coil Units

Units shall include galvanized coil casing, coil assembly drain pan valve and piping package, air filter, fans, motor, fan drive, and motor switch, plus an enclosure for horizontal suspended units. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Each unit shall be supported securely from the building structure. Capacity of the units shall be as indicated. Room fan-coil units shall be certified as complying with ARI 440, and shall meet the requirements of UL 1995.

##### 2.11.1.1 Enclosures

Duct discharge collar shall be provided for concealed models. Enclosures shall have easy access for filter replacement.

##### 2.11.1.2 Fans

Fans shall be galvanized steel or aluminum, multiblade, centrifugal type. In lieu of metal, fans and scrolls may be non-metallic materials of suitably reinforced compounds. Fans shall be dynamically and statically balanced. Surfaces shall be smooth. Assemblies shall be accessible for maintenance. Disassembly and re-assembly shall be by means of mechanical fastening devices and not by epoxies or cements.

##### 2.11.1.3 Coils

Coils shall be constructed of not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Coils shall be provided with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Coils shall be tested hydrostatically at 300 psi or under water at 250 psi air pressure and suitable for 200 psi working pressure. Provisions shall be made for coil removal.

##### 2.11.1.4 Drain Pans

Drain and drip pans shall be sized and located to collect all water condensed on and dripping from any item within the unit enclosure or casing. Condensate drain pans shall be designed for self-drainage to preclude the buildup of microbial slime and shall be thermally insulated to prevent condensation and constructed of not lighter than 21 gauge type 304 stainless steel or noncorrosive ABS plastic. Insulation shall have a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and shall be of a waterproof type or coated with a waterproofing material. Drain pans shall be pitched to drain and shall be designed so as to allow no standing water.

Minimum 3/4 inch NPT or 5/8 inch OD drain connection shall be provided in drain pan. Auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages, may be plastic; if metal, the auxiliary pans shall comply with the requirements specified above. Insulation at control and piping connections thereto shall extend 1 inch minimum over the auxiliary drain pan.

## 2.11.1.5 Filters

Filters shall be of the fiberglass disposable type, 1 inch thick, conforming to CID A-A-1419. Filters in each unit shall be removable without the use of tools.

## 2.11.1.6 Motors

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Motor switch shall be two or three speeds and off, manually operated, and shall be mounted on an identified plate adjacent to the room thermostat. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent may be provided. Motors shall have permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity shall not exceed the following values:

## Free Discharge Motors

Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
200	70	110	90
300	100	110	110
400	170	150	150
600	180	210	220
800	240	240	230
1000	310	250	270
1200	440	400	440

## 2.11.2 Variable Air Volume (VAV) Units

VAV terminal units shall be the type, size, and capacity shown and shall be mounted in the ceiling or wall cavity and shall be suitable for single system applications. Actuators and controls shall be as specified in paragraph CONTROLS. Unit enclosures shall be constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge.

Single or multiple discharge outlets shall be provided as required. Units with flow limiters are not acceptable. Unit air volume shall be factory preset and readily field adjustable without special tools. Reheat coils shall be provided as indicated. A flow chart shall be attached to each unit. Acoustic performance of the terminal units shall be based upon units tested according to ARI 880. Sound power level shall be as indicated on the Drawings.

## 2.11.2.1 Constant Volume, Single Duct

Constant volume, single duct, terminal units shall be the same as variable volume, single duct units, set for a constant volume.

## 2.11.2.2 Variable Volume, Single Duct

Variable volume, single duct, terminal units shall be direct digital control, pressure independent and shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays.

Units shall control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement with a 0 to 1 inch water gauge range. Units shall be provided with reheat units where indicated.

#### 2.11.2.3 Reheat Units

a. Hot Water Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 16 gauge, galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 250 psi air pressure and shall be suitable for 200 psi working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.

#### 2.12 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

##### 3.1.1 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 6 inch concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided.

The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.2 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METALS.

#### 3.1.3 Flexible Connectors

Flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

#### 3.1.4 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900A JOINT SEALING.

#### 3.1.5 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

#### 3.1.6 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

### 3.1.7 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated.

### 3.1.8 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

### 3.1.9 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

### 3.1.10 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

## 3.2 FIELD PAINTING AND IDENTIFICATION SYSTEMS

### 3.2.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number shall be installed on all valves and dampers. Tags shall be 1-3/8 inch minimum diameter and marking shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

### 3.2.2 Finish Painting and Pipe Color Code Marking

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 3.2.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch diameter and secured to removable ceiling panels with fasteners. Each fastener shall be inserted into the ceiling panel so as to be concealed from view. The fasteners shall be manually removable without the use of tools and shall not separate from the ceiling panels when the panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall

be approximately 3 foot wide, 30 inches high, and 1/2 inches thick. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. The color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted in the mechanical or equipment room.

### 3.3 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, filters, etc. Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. The maximum allowable leakage rate shall be as indicated on the drawings.

### 3.4 DAMPER ACCEPTANCE TEST

All fire dampers and smoke dampers shall be operated under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Fire dampers equipped with fusible links shall be tested by having the fusible link cut in place. Dynamic fire dampers shall be tested with the air handling and distribution system running. All fire dampers shall be reset with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, the damper must be installed so it is square and free from racking.

### 3.5 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

### 3.6 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 5 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

### 3.7 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of room fan-coil units air terminal units, ducts, plenums, and casing shall be thoroughly cleaned



of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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## SECTION 15951A

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12/01

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## SECTION 15951A

DIRECT DIGITAL CONTROL FOR HVAC  
**12/01**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D (1998) Laboratory Methods of Testing  
Dampers for Rating

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/EIA/TIA-232-F (1991) Interface Between Data Technical  
Equipment and Data Circuit-Terminating  
Equipment Employing Serial Binary Data  
Interchange

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

IEEE Std 142 (1991) IEEE Recommended Practice for  
Grounding of Industrial and Commercial  
Power Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ST 1 (1988) Specialty Transformers (Except  
General-Purpose Type)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 90A (1996) Installation of Air Conditioning  
and Ventilating Systems

## UNDERWRITERS LABORATORIES (UL)

UL 268A (1998) Smoke Detectors for Duct Application

UL 508 (1993; Rev thru Oct 1997) Industrial

## Control Equipment

### 1.2 GENERAL REQUIREMENTS

The direct digital control (DDC) shall be a complete system suitable for the heating, ventilating and air-conditioning (HVAC) system. The system shall be Lon-Works or BacNet compatible so that all data can be read and reset from a remote web-based EMCS system.

#### 1.2.1 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

#### 1.2.2 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 1.2.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

#### 1.2.4 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected from power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

#### 1.2.5 Surge Protection for Transmitter and Control Wiring

DDC system control-panel equipment shall be protected against surges induced on control and transmitter wiring installed outside and as shown. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

a. A 10-microsecond by 1,000-microsecond waveform with a peak voltage of 1,500 volts and a peak current of 60 amperes.

b. An eight microsecond by 20-microsecond waveform with a peak voltage of 1,000 volts and a peak current of 500 amperes.

#### 1.2.6 System Overall Reliability Requirement

The system shall be configured and installed to yield a mean time between failure (MTBF) of at least 40,000 hours. Each DDC controller shall be designed, configured, installed and programmed to provide for stand alone operation with minimal performance degradation on failure of other system

components to which it is connected or with which it communicates.

#### 1.2.7 DDC System Network Accessibility

Where the systems to be controlled by the DDC system are located in multiple mechanical rooms, each mechanical room shall have at least one communication port for the portable workstation/tester. DDC controllers shall be located in the same room as the equipment being controlled or in an adjacent space which has direct access to the equipment room. Provide fiber optic cable between the Headquarters Building and the Company Operations Facility Building installed in a communications duct bank. The duct bank is furnished and installed under the Electrical Division of the Specifications.

#### 1.2.8 System Accuracy and Display

The system shall maintain an end-to-end accuracy for one year from sensor to operator's console display for the applications specified and shall display the value as specified. Each temperature shall be displayed and printed to nearest 0.1 degree F.

##### 1.2.8.1 Space Temperature

Space temperature with a range of 50 to 85 degrees F plus or minus 0.75 degree F for conditioned space; 30 to 130 degrees F plus or minus 1 degree F for unconditioned space.

##### 1.2.8.2 Duct Temperature

Duct temperature with a range of 40 to 140 degrees F plus or minus 2 degrees F.

##### 1.2.8.3 Outside Air Temperature

Outside air (OA) temperature with a range of minus 30 to plus 130 degrees F plus or minus 2 degrees F; with a subrange of 30 to 100 degrees F plus or minus 1 degree F.

##### 1.2.8.4 Water Temperature

Water temperature with a range of 30 to 100 degrees F plus or minus 0.75 degree F; the range of 100 to 250 degrees F plus or minus 2 degrees F; and water temperatures for the purpose of performing Btu calculations using differential temperatures to plus or minus 0.5 degree F using matched sensors.

##### 1.2.8.5 Relative Humidity

Relative humidity, within a range of 20 to 80 percent, plus or minus 6.0 percent of range (display and print to nearest 1.0 percent).

##### 1.2.8.6 Pressure

Pressure with a range for the specific application plus or minus 2.0 percent of range (display and print to nearest psi.)

##### 1.2.8.7 Flow

Flow with a range for the specific application plus or minus 3.0 percent of



range, and flows for the purpose of thermal calculations to plus or minus 2.0 percent of actual flow (display and print to nearest unit, such as gallons per minute).

#### 1.2.8.8 KWh and kW Demand

KWh and kW demand with a range for the specific application plus or minus 1.0 percent of reading (display and print to nearest kWh or kW).

#### 1.2.8.9 Analog Value Input

An analog value input to the system's equipment via an AI with a maximum error of 0.50 percent of range, not including the sensor or transmitter error. This accuracy shall be maintained over the specified environmental conditions.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### HVAC Control System; G, AE

Drawings shall be on 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and identifiers shown. Each control system element on a drawing shall have a unique identifier as shown. The HVAC Control System Drawings shall be delivered together as a complete submittal. Deviations must be approved by the Contracting Officer. Drawings shall be submitted along with Submittal SD-01, Data.

#### a. HVAC Control System Drawings shall include the following:

Sheet One: Drawing Index, HVAC Control System Legend.

Sheet Two: Valve Schedule, Damper Schedule.

Sheet Three: Control System Schematic and Equipment Schedule.

Sheet Four: Sequence of Operation and Data Terminal Strip Layout.

Sheet Five: Control Loop Wiring Diagrams.

Sheet Six: Motor Starter and Relay Wiring Diagram.

Sheet Seven: Communication Network and Block Diagram.

Sheet Eight: DDC Panel Installation and Block Diagram.

(Repeat Sheets Four through Seven for each AHU System.)

#### b. The HVAC Control System Drawing Index shall show the name

and number of the building, military site, State or other similar designation, and Country. The Drawing Index shall list HVAC Control System Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. The HVAC Control System Legend shall show generic symbols and the name of devices shown on the HVAC Control System Drawings.

c. The valve schedule shall include each valve's unique identifier, size, flow coefficient Cv, pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data. Valve schedules may be submitted in advance but shall be included in the complete submittal.

d. The damper schedule shall contain each damper's and each actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule shall include the maximum leakage rate at the operating static-pressure differential. The Damper Schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements. Damper schedules may be submitted in advance but shall be included in the complete submittal.

e. The HVAC control system schematics shall be in the form shown, and shall show all control and mechanical devices associated with the HVAC system. A system schematic drawing shall be submitted for each HVAC system.

f. The HVAC control system equipment Schedule shall be in the form shown. All devices shown on the drawings having unique identifiers shall be referenced in the equipment schedule. Information to be included in the equipment schedule shall be the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e., output range). An equipment schedule shall be submitted for each HVAC system.

g. The HVAC control system sequence of operation shall reflect the language and format of this specification, and shall refer to the devices by their unique identifiers as shown. No operational deviations from specified sequences will be permitted without prior written approval of the Contracting Officer. Sequences of operation shall be submitted for each HVAC control system including each type of terminal unit control system.

h. The HVAC control system wiring diagrams shall be functional wiring diagrams which show the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged equipment control systems shall be identified back to the panel board circuit breaker number, HVAC system control panel, magnetic

starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown. Wiring diagrams shall be submitted for each HVAC control system.

#### SD-03 Product Data

##### Service Organizations; G, RE

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

##### Equipment Compliance Booklet; G, AE

The HVAC Control System Equipment Compliance Booklet (ECB) shall be in booklet form and indexed, with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a Bill of Materials for each HVAC Control System. The Bill of Materials shall function as the Table of Contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB. The ECB shall be submitted along with Submittal SD-04, Drawings. Variable frequency drives information shall be furnished in this booklet.

##### Commissioning Procedures; G, RE

Six copies of the HVAC control system commissioning procedures, in booklet form and indexed, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal unit control system. The Commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The Commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

a. The Commissioning procedures shall include detailed, product specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

b. An HVAC control system commissioning procedures equipment list shall be included that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest

calibration, and the results of the latest calibration.

Performance Verification Test Procedures; G, RE

Six copies of the HVAC Control System Performance Verification Test Procedures, in booklet form and indexed, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation, and other contract documents. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training; G, RE

An outline for the HVAC control system training course with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training. Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course.

SD-06 Test Reports

Commissioning Report; G, RE

Six copies of the HVAC Control System Commissioning Report, in booklet form and indexed, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning procedures and shall follow the format of the commissioning procedures. The commissioning report shall include all configuration checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, results of adjustments, and results of testing.

Performance Verification Test; G, RE

Six copies of the HVAC Control System Performance Verification Test Report, in booklet form and indexed, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of all data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-10 Operation and Maintenance Data

Operation Manual; G, RE

Maintenance and Repair Manual; G, RE

Six copies of the HVAC Control System Operation Manual and HVAC Control System Maintenance and Repair Manual, for each HVAC control system, 30 days before the date scheduled for the training course.

#### 1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

#### 1.5 OPERATION MANUAL

An HVAC control system operation manual in indexed booklet form shall be provided for each HVAC control system. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built configuration checksheets, the procedures for changing HVAC control system setpoints, and the procedures for placing HVAC system controllers in the manual control mode.

a. The procedures for changing HVAC control system setpoints shall describe the step-by-step procedures required to change the process variable setpoints, the alarm setpoints, the bias settings, and setpoint reset schedules.

b. The procedures for placing HVAC system controllers in the manual control mode shall describe step-by-step procedures required to obtain manual control of each controlled device and to manually adjust their positions.

#### 1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual in indexed booklet form in hardback binders shall be provided for each HVAC control system. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet.

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment data compliance booklet and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet shall include the equipment compliance booklet and manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

#### 1.7 MAINTENANCE AND SERVICE

Services, materials and equipment shall be provided as necessary to maintain the entire system in an operational state as specified for a period of one year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized. The manufacturer shall maintain the required service organizations within 100 miles of this facility.

##### 1.7.1 Description of Work

The adjustment and repair of the system shall include the manufacturer's required adjustments of computer equipment, software updates, transmission equipment and instrumentation and control devices.

##### 1.7.2 Personnel

Service personnel shall be qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

##### 1.7.3 Scheduled Inspections

Two inspections shall be performed at six-month intervals and all work required shall be performed. Inspections shall be scheduled in June and December. These inspections shall include:

- a. Visual checks and operational tests of equipment.
- b. Fan checks and filter changes for control system equipment.
- c. Clean control system equipment including interior and exterior surfaces.
- d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog points during the first inspection. Check and calibrate the remaining 50 percent of the analog points during the second major inspection. Certify analog test instrumentation accuracy to be twice that of the device being calibrated. Randomly check at least 25 percent of all digital points for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital points during the second inspection.
- e. Run system software diagnostics and correct diagnosed problems.
- f. Resolve any previous outstanding problems.

##### 1.7.4 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays.

#### 1.7.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition within three calendar days after receiving a request for service.

#### 1.7.6 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

#### 1.7.7 Records and Logs

Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

#### 1.7.8 Work Requests

Each service call request shall be recorded as received and shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

#### 1.7.9 System Modifications

Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

#### 1.7.10 Software

Updates to the software shall be provided for system, operating and application software, and operation in the system shall be verified. Updates shall be incorporated into operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the latest released version of the Contractor's software shall be installed and validated.

### PART 2 PRODUCTS

#### 2.1 GENERAL EQUIPMENT REQUIREMENTS

Units of the same type of equipment shall be products of a single

manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two years' use shall include applications of equipment and materials under similar circumstances and of similar size. The two years' experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6,000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Automatic temperature controls shall be direct digital controls that will provide the required sequence of operation.

#### 2.1.1 Electrical and Electronic Devices

Electrical, electronic, and electropneumatic devices not located within a DDC panel shall have a NEMA ICS 1 enclosure in accordance with NEMA 250 unless otherwise shown.

#### 2.1.2 Standard Signals

Except for air distribution terminal unit control equipment, the output of all analog transmitters and the analog input and output of all DDC controllers shall be 4-to-20 mA<sub>dc</sub> signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

#### 2.1.3 Ambient Temperature Limits

DDC panels shall have ambient condition ratings of 35 to 120 degrees F and 10 to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 35 to plus 150 degrees F. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

#### 2.1.4 Year 2000 Compliance

All equipment and software shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations, when used in accordance with the product documentation provided by the contractor, provided that all products (e.g. hardware, software, firmware) used in combination with other information technology, shall accurately process date/time data if other information technology properly exchanges date/time data with it.



## 2.2 WIRING

### 2.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

### 2.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

### 2.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

### 2.2.4 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single- or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

### 2.2.5 Transformers

Step down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508 and NEMA ST 1.

## 2.3 ACTUATORS

Actuators shall be electric or electronic as shown and shall be provided with mounting and connecting hardware. Electric or electronic actuators shall be used for variable air volume (VAV) air terminal units. Actuators shall fail to their spring-return positions on signal or power failure, except that VAV terminal unit actuators may be of the floating type. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less. Electric actuators shall have an oil-immersed gear train. Electric or electronic actuators operating in series shall have an auxiliary actuator driver. Electric or electronic actuators used in sequencing applications shall have an adjustable operating range and start point.

### 2.3.1 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of

operation.

## 2.4 AUTOMATIC CONTROL VALVES

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Unless otherwise stated, valves shall have globe style bodies. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv. Unless otherwise specified, bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends; bodies for 2 inch valves shall have threaded ends; and bodies for valves 2 to 3 inches shall be of brass, bronze or iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 to 125 percent of the Cv shown.

### 2.4.1 Butterfly Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 20 to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator. The rated Cv for butterfly valves shall be the value Cv at 70% open (60 degrees open).

### 2.4.2 Two-Way Valves

Two-way valves shall be two-position type.

### 2.4.3 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

### 2.4.4 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be furnished for each flare-type end valve.

### 2.4.5 Valves for Chilled-Water Service

Internal valve trim shall be bronze except that valve stems may be type 316 stainless steel. Valve Cv shall be within 100 to 125 percent of the Cv shown. Valves 4 inches and larger shall be butterfly.

### 2.4.6 Valves for Hot-Water Service

For hot water service below 250 degrees F, internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches and larger shall be butterfly valves.

## 2.5 DAMPERS

### 2.5.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Damper axles shall be 0.5 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 feet per minute in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

### 2.5.2 Operating Links

Operating links external to dampers, such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

### 2.5.3 Damper Types

Mixing dampers shall be parallel-blade high efficiency mixing type.

#### 2.5.3.1 Outside Air, Return Air, and Relief Air Dampers

Outside air, return air and relief air dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gauge static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 200 degrees F. Dampers shall be rated at not less than 2,000 feet per minute air velocity.

#### 2.5.3.2 Mechanical and Electrical Space Ventilation Dampers

Mechanical and electrical space ventilation dampers shall be as shown. Dampers shall not leak in excess of 80 cfm square foot at 4 inches water gauge static pressure when closed. Dampers shall be rated at not less than 1,500 feet per minute air velocity.

### 2.5.4 Damper End Switches

Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

## 2.6 SMOKE DETECTORS

Duct smoke detectors shall be provided in supply and return air ducts in accordance with NFPA 90A. Duct smoke detectors shall conform to the requirements of UL 268A. Duct smoke detectors shall have perforated sampling tubes extended into the air duct. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm control panel (FACP). Detectors shall have two sets of normally open alarm contacts and two sets of normally closed alarm contacts. Detectors shall be connected to the building fire alarm panel for alarm initiation. A remote annunciation lamp and accessible remote reset switch shall be provided for duct detectors that are mounted eight feet or more above the finished floor and for detectors that are not readily visible. Remote lamps and switches as well as the affected fan units shall be properly identified in etched rigid plastic placards.

## 2.7 INSTRUMENTATION

### 2.7.1 Measurements

Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for an output of 4 to 20 mAdc:

- a. Conditioned space temperature, from 50 to 85 degrees F.
- b. Duct temperature, from 40 to 140 degrees F.
- c. Chilled-water temperature, from 30 to 100 degrees F.
- d. Heating hot-water temperature, from 50 to 250 degrees F.
- e. Outside-air temperature, from minus 30 to 130 degrees F.
- f. Relative humidity, 0 to 100 percent for space and duct high-limit applications.
- g. Differential pressure for VAV supply-duct static pressure from 0 to 2.0 inches water gauge.
- h. Electronic air-flow measurement station and transmitter, from 125 to 2500 fpm.

### 2.7.2 Temperature Instruments

#### 2.7.2.1 Resistance Temperature Detectors (RTD)

Temperature sensors shall be 100 ohms 3- or 4-wire RTD. Each RTD shall be platinum with a tolerance of 0.54 degrees F at 32 degrees F with a temperature coefficient of resistance (TCR) of .00214 ohms/ohm/deg F and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified, integrally mounted unless otherwise shown.

#### 2.7.2.2 Continuous Averaging RTD

Continuous averaging RTDs shall have a tolerance of plus or minus 1.0 degree F at the reference temperature, and shall be of sufficient length to

ensure that the resistance represents an average over the cross section in which it is installed. The sensing element shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter to match the resistance range of the averaging RTD.

#### 2.7.2.3 RTD Transmitter

The RTD transmitter shall match the resistance range of the RTD. The transmitter shall be a two-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mA<sub>dc</sub> output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated measurement.

#### 2.7.3 Relative Humidity Instruments

A relative-humidity instrument for indoor application shall have a measurement range from 0 to 100 percent relative-humidity and be rated for operation at ambient air temperatures within the range of 25 to 130 degrees F. It shall be capable of being exposed to a condensing air stream (100 percent RH) with no adverse effect to the sensor's calibration or other harm to the instrument. The instrument shall be of the wall-mounted or duct-mounted type, as required by the application, and shall be provided with any required accessories. Instruments used in duct high-limit applications shall have a bulk polymer resistive sensing element. Duct-mounted instruments shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. The instrument (sensing element and transmitter) shall be a two-wire, loop-powered device and shall have an accuracy of plus or minus three percent of full scale within the range of 20 to 80 percent relative humidity. The instrument shall have a typical long-term stability of 1 percent or less drift per year. The transmitter shall convert the sensing element's output to a linear 4-20 mA<sub>dc</sub> output signal in proportion to the measured relative-humidity value. The transmitter shall include offset and span adjustments.

#### 2.7.4 Electronic Airflow Measurement Stations and Transmitters

##### 2.7.4.1 Stations

An airflow measuring station may be mounted in the AHU fan inlets. This unit shall be designed for mounting in fan cone inlets and shall have an accuracy of plus or minus 3 percent of the airflow. Each station shall consist of an array of velocity sensing elements and an air-flow straightener when duct mounted. Air-flow straightener shall be contained in a flanged sheet metal or aluminum casing. The velocity sensing elements shall be of the RTD or thermistor type, producing a temperature compensated output. The sensing elements shall be distributed across the duct or fan cross section in the quantity and pattern specified by the published application data of the station manufacturer. The resistance to air flow through the airflow measurement station shall not exceed 0.08 inch water gauge at an airflow of 2,000 fpm. Station construction shall be suitable for operation at airflows of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus three percent over a range of 125 to 2,500 fpm. In outside air measurement or in low-temperature air delivery applications, the station shall be certified by the manufacturer to be accurate as specified over a temperature range of minus 20 to plus 120 degrees F. In outside air measurement applications, the air flow straightener shall be constructed of 1/8 inch aluminum honeycomb and the depth of the straightener shall not be less than

1.5 inches.

#### 2.7.4.2 Transmitters

Each transmitter shall produce a linear, 4-to-20 mAdc, output corresponding to the required velocity pressure measurement. The transmitter shall be a two-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the calibrated measurement.

#### 2.7.4.3 Variable Frequency Motor Drives

The variable frequency drive (VFD) shall convert 460 volt (+/- 10%), three phase, 60 hertz (+/- 2 Hz), utility grade power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5% to 105% of base speed. The drive shall be coordinated with Air Handling Units Section 15895.

a. Description: The variable frequency drive (VFD) shall produce an adjustable AC voltage/frequency output for complete motor speed control. The VFD must meet all of the following criteria.

- (1) The VFD shall use sinecoded PWM technology. The sinecoded PWM calculations are performed by the VFD microprocessor.
- (2) The VFD shall use IGBT transistors for the inverter's three phase output.
- (3) The VFD shall use a three phase diode bridge converter to charge the VFD constant voltage capacitor buss.
- (4) The VFD shall have the ability for control by either a remote 4-20 mA, or 0 to 10 VDC control signal or from a local control panel located on the VFD itself.
- (5) The VFD shall use microprocessor technology for VFD control. The VFD shall be programmable with a permanently mounted keypad included with each VFD.
- (6) The VFD shall be fully self diagnostic. No external programmers, analyzers, interrogators, or diagnostic boards, shall be needed to annunciate VFD faults or drive internal status.

b. Code Standards: VFD shall be UL listed as delivered to the end user. The VFD shall meet current National Electrical Code.

c. VFD Quality Assurance: To ensure quality, each and every VFD shall be subject to a series of in-plant quality controlled inspections before approval for shipment from the manufacturer's facilities.

- (1) To ensure quality, each and every VFD shall be subject to a series of in-plant quality controlled inspections before approval for shipment from the manufacturer's facilities.
- (2) The VFDs shall be the current standard production unit with at least 10 identical units already in the field.
- (3) Engineering support shall be available from the factory of the VFD. Phone support shall be free of charge to the end user for the life of the equipment. Factory support shall be available in

the English language.

d. VFD Service: The VFD service shall be supplied with:

(1) 24 month parts and labor warranty. The warranty shall start when the system is accepted by the end user or 30 months from date of shipment.

(2) Installation, operation, and troubleshooting guide(s).

(3) A district service support group shall provide the following additional services:

(a) Factory trained personal on-site for start-up for up to one working day for each VAV drive unit at no additional cost. Personnel shall be competent in operation and repair of the particular model of VFD that is installed.

(b) On-site training of customer personnel in basic installation, troubleshooting, and operation of VFDs at no additional cost. This training shall be conducted for up to 6 personnel at the installation site for a minimum of 4 hours.

e. Basic VFD Features: The VFD shall have the following basic features with no more than three separate internal electronic boards.

(1) VFD mounted operator control keypad capable of:

(a) Remote/Local operator selection with password access.

(b) Run/Stop and manual speed commands.

(c) All programming functions.

(d) Scrolling through all display functions.

(2) Digital display capable of indicating:

(a) VFD status.

(b) Frequency.

(c) RPM of motor.

(d) Phase current.

(e) Fault diagnostics in descriptive text.

(f) All programmed parameters.

(3) Standard PI loop controller with input terminal for controlled variable and parameter settings made while inverter running.

(4) User interface terminals for end-user remote control of VFD speed, speed feedback, and isolated form C SPDT relay energized on drive fault condition.

(5) An isolated form C SPDT auxiliary relay energized on run command.

(6) The VFD shall have a metal NEMA 1 enclosure. See Manual Selector Switch, hereinafter specified.

(7) The VFD shall have an adjustable carrier frequency with 16 KHz minimum upper limit.

(8) The VFD shall have a built in or external line reactor with 3% minimum impedance to protect DC buss capacitors and rectifier section diodes.

f. Programmable Parameters: The VFD shall include the following operator programmable parameters:

- (1) Upper limit frequency.
- (2) Lower limit frequency.
- (3) Acceleration rate.
- (4) Deceleration rate.
- (5) Variable torque volts per Hertz curve.
- (6) Starting voltage level.
- (7) Starting frequency level.
- (8) Display speed scaling.
- (9) Enable/disable auto-restart feature.
- (10) Enable/disable softstall feature.
- (11) Motor overload level.
- (12) Motor stall level.
- (13) Jump frequency and hysteresis band.
- (14) PWM carrier frequency.

g. Protective Circuits and Features

(1) An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

(2) An electronic adjustable soft stall feature, allowing the VFD to lower the frequency to a point where the motor will run at FLA when an overload condition exists at the requested frequency. The VFD will automatically return to the requested frequency when load condition permit.

(3) The VFD will have a separate electronic stall at 110% VFD rated current and a separate hardware trip at 190% current.

(4) The VFD shall have ground fault protection that protects output cables and motor from grounds during both starting and continuous running conditions.

(5) The VFD shall have the ability to restart after the following faults:

- (a) Overcurrent (drive or motor).
- (b) Power outage.
- (c) Phase loss.



- (d) Overvoltage/undervoltage.
- (6) The VFD shall restart into a rotating load without tripping or damaging the VFD or the motor.
- (7) The VFD shall keep a log of a minimum of four previous fault conditions, indicating type and time of occurrence in descriptive text.
- (8) The VFD shall be able to sustain 110% rated current for 60 sec.
- (9) The VFD shall respond to and record the following fault conditions:
  - (a) Overcurrent (and have an indication if the over current was during acceleration, deceleration, or running).
  - (b) Overcurrent internal to the drive.
  - (c) Motor overload at start-up.
  - (d) Over voltage from the utility power.
  - (e) Motor running overload.
  - (f) Overvoltage during deceleration.
  - (g) VFD over heat.
  - (h) Load end ground fault.
  - (i) Abnormal parameters or data in VFD EEPROM.
- h. Operational Conditions: The VFD shall be designed and constructed to operate within the following service conditions:
  - (1) Ambient Temperature Range, 0 to 120 deg. F.
  - (2) Non-condensing relative humidity to 90%.
- i. Available Options: Provide the following features:
  - (1) RFI/EMI filters.
  - (2) RS232 or RS422/485 interface card with application software which can both control and monitor the VFD from a attached computer.
  - (3) A manual lockable drive bypass, fused disconnect on "Drive on-Drive Off" selector switch with a manual bypass circuit and bypass disconnect switch integral to the drive to allow drive bypass to operate at 100% speed. Overload fuses and other protective hardware shall remain in the circuit during bypass.
  - (4) One set of spare parts per drive including: all replaceable circuit cards, power diode assemble, DC Buss capacitor, power output transistor assembly, all fuses, and all lights. Package parts individually for long term storage and clearly label

contents.

#### 2.7.5 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus two percent of full scale.

#### 2.7.6 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 2 inch lagging neck and extension type well. Inside diameter and insertion length shall be as required for the application.

#### 2.7.7 Sunshields

Sunshields for outside air temperature sensing elements shall prevent the sun from directly striking the temperature sensing elements. The sunshields shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sunshield shall have a galvanized metal rainshield projecting over the face of the sunshield. The sunshields shall be painted white.

### 2.8 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

#### 2.8.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 5 degrees F. Room thermostats shall be enclosed with separate locking covers (guards).

#### 2.8.2 Modulating Room Thermostats

Modulating room thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output. Room thermostats shall be enclosed with separate locking covers (guards).

#### 2.8.3 Nonmodulating Capillary Thermostats and Aquastats

Each thermostat shall have a capillary length of at least 5 feet, shall have adjustable direct-reading scales for both setpoint and differential, and shall have a differential adjustable from 6 to 16 degrees F. Aquastats shall be of the strap on type, with 10 degrees F fixed differential.

#### 2.8.4 Freezestats

Freezestats shall be manual reset, low temperature safety thermostats, with NO and NC contacts and a 20 foot element which shall respond to the coldest 18 inch segment.

### 2.8.5 Modulating Capillary Thermostats

Each thermostat shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output.

### 2.8.6 Fan-Coil Unit Room Thermostats

Fan-coil unit thermostats in personnel living spaces shall be of the low voltage type with locking covers. Electrical rating shall not exceed 2.5 amperes at 30 volts ac. Housing shall be corrosion resisting metal or molded plastic. Transformer and fan relay shall be provided for the proper operation of each thermostatic control system as necessary to suit the design of the control system using the thermostats specified below. Either separate heating thermostats and separate cooling thermostats or dual element heating cooling thermostats may be provided. Motor speed switches shall be provided for three-speed fan control.

#### 2.8.6.1 Cooling Thermostat

Fan-coil cooling thermostats shall be provided with fixed cooling anticipation heater and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set minimum of 78 degrees F. Cooling thermostats shall have an adjustable range of at least 7 degrees above 78 degrees F.

## 2.9 PRESSURE SWITCHES AND SOLENOID VALVES

### 2.9.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

#### 2.9.2 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. The setpoint shall not be in the upper or lower quarters of the range and the range shall not be more than three times the setpoint. Differential shall be a maximum of 0.15 inch water gauge at the low end of the range and 0.35 inch water gauge at the high end of the range.

## 2.10 INDICATING DEVICES

### 2.10.1 Thermometers

Mercury shall not be used in thermometers.

#### 2.10.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Thermometers for piping systems shall have rigid stems with

straight, angular, or inclined pattern.

#### 2.10.1.2 Piping System Thermometer Stems

Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

#### 2.10.1.3 Nonaveraging Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

#### 2.10.1.4 Averaging Air-Duct Thermometers

Averaging thermometers shall have a 3-1/2 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270-degree arc.

#### 2.10.1.5 Accuracy

Thermometers shall have an accuracy of plus or minus one percent of scale range. Thermometers shall have a range suitable for the application.

#### 2.10.2 Pressure Gauges

##### 2.10.2.1 Hydronic System Gauges

Gauges for hydronic system applications shall have ranges and graduations as shown.

#### 2.10.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements shall be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus two percent of scale range.

### 2.11 CONTROL DEVICES AND ACCESSORIES

#### 2.11.1 Relays

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of two sets of contacts (two normally open, two normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Time delay relays shall be 2PDT with eight-pin connectors, dust cover, and a matching rail-mounted socket. Adjustable timing range shall be 0 to 5 minutes. Power consumption shall not be greater than three watts.

#### 2.11.2 Current Sensing Relays

Current sensing relays shall provide a normally-open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, noninductive. There shall be a single hole for passage of current carrying conductors. The devices shall be sized for operation at 50 percent rated current based on

the connected load. Voltage isolation shall be a minimum of 600 volts.

### 2.11.3 Joule or Watthour Transducers

Joule Watthour transducers shall have an accuracy of plus or minus 0.25 percent for kW and Joule kWh outputs from full lag to full lead power factor. Input ranges for kW and Joule kWh transducers shall be selectable without requiring the changing of current or potential transformers. The output shall be 4 to 20 mAdc.

### 2.12 DIRECT DIGITAL CONTROL (DDC) HARDWARE

All functions, constraints, data base parameters, operator developed programs and any other data shall be downloadable from a portable workstation/tester or the central workstation/tester to network control panels, RIU's, universal programmable controllers, and unitary controllers. Download shall be accomplished through both the primary network and the local DDC portable workstation/tester port.

#### 2.12.1 Network Control Panel

Network control panels shall be microcomputer-based with sufficient memory provided to perform all specified and shown network control panel functions and operations, including spare capacity for all spares and its I/O functions specified. Each network control panel and remote I/O units (RIU) shall have a minimum of 10% of its I/O functions as spare capacity but not less than 2 of each type used in each. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall there be less than two spare points of each type. The panel I/O functions shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points shall necessitate only providing the additional field sensor or control device, field wiring including connection to the system, and point definition assignment by the operator using the central workstation/tester or portable workstation/tester. The panel shall contain all necessary I/O functions to connect to field sensors and control panels. I/O function operation shall be fully supervised to detect I/O function failures. Network control panels shall operate in an independent stand-alone mode, which is defined as all network control panel operations performed by the network control panel without any continuing input from other Direct digital controls or portable workstation/tester. The network control panel shall be capable of controlling a mix of at least 32 RIUs, unitary controllers, and universal programmable controllers.

##### 2.12.1.1 Integral Features

The network control panel shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and if necessary power supply.
- d. Manufacturers control network port.

e. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the field panel, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.

f. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual output override, for each AO. The status of these shall be available to the panel for further processing.

g. An intrusion detection device, connected as an alarm.

#### 2.12.1.2 Communication Interfaces

The following communication capabilities shall function simultaneously.

a. Manufacturers Control Network. Manufacturers control network communications interfaces for each data transmission systems (DTS) circuit between network control panels and RIUs, unitary controllers, and universal programmable controllers, shall be provided. Communication interfaces shall be provided between each network control panel and associated I/O functions. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the network control panel enclosure.

b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. Network control panel workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel.

c. Primary Network Port. The network control panel shall either have a built in primary network Port or be capable of accepting a primary network port expansion card for future networking to a base wide utility monitoring and control system (UMCS). The primary network port expansion card shall be either Ethernet (IEEE802.3) or ARCNET.

#### 2.12.1.3 Memory and Real Time Clock (RTC) Backup

The network control panel memory and real time clock functions shall continue to operate for a minimum of 72 hours in the event of a power failure. If rechargeable batteries are provided, automatic charging of batteries shall be provided. Whenever a either a permanent workstation/tester or portable workstation/tester is monitoring the network control panel, a low battery alarm message shall be sent to it.

#### 2.12.1.4 Duplex Outlet

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the network control panel enclosure.

#### 2.12.1.5 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each network control panel.

#### 2.12.1.6 Failure Mode

Upon failure of the network control panel, either due to failure of the network control panel hardware or of the manufacturers control network, the network control panel shall revert to the failure mode as shown.

a. Manufacturers Control Network Failure: Upon failure of the manufacturers control network, the network control panel shall operate in an independent stand-alone mode.

b. Network Control Panel Hardware Failure: Upon failure of the network control panel hardware, the network control panel shall cease operation and stop communications with other network control panels, RIUs, unitary controllers and universal programmable controllers connected to the affected network control panel. The affected network control panel shall respond to this failure as specified and shown.

#### 2.12.2 RIU

The RIU shall be functionally a part of the network control panel as specified, but may be remotely located from the network control panel and communicate over a dedicated communication circuit. When remotely located, the I/O functions shall be subject to the same requirements as for the network control panel hardware. RIUs shall be used to connect remote inputs and outputs to a network control panel and shall contain all necessary I/O functions to connect to field sensors and control devices. RIU operation shall be fully supervised by the network control panel to detect failures. Each RIU shall have a minimum of 10 % of its I/O functions as spare capacity. The type of spares shall be in the same proportion as the implemented I/O functions on the RIU, but in no case shall there be less than two spare points of each type. The RIU shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points by others shall require only providing the additional field sensor or control device, field wiring including connection to the system, and point definition assignment by the operator. The RIU shall either report the status of all connected points on each scan, or report the status of all points which have changed state or value since the previous scan.

##### 2.12.2.1 Integral Features

The RIU shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and if necessary power supply.
- d. Manufacturers control network port.
- e. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the RIU, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the RIU

for further processing.

- f. An intrusion detection device, connected as an alarm.

#### 2.12.2.2 Duplex Outlet

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the RIU.

#### 2.12.2.3 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each RIU.

#### 2.12.2.4 Failure Mode

Upon failure of the RIU, either due to failure of the RIU hardware or of the DTS, the RIU shall revert to the failure mode shown.

#### 2.12.3 Universal Programmable Controller (UPC)

The universal programmable controller shall be a microprocessor based controller designed and programmed to control and monitor systems as shown.

Resident programs shall be contained in reprogrammable nonvolatile memory. Each universal programmable controller shall contain necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide control and monitoring of connected equipment and devices. It shall contain all necessary I/O functions to connect to field sensors and controls. I/O operation shall be fully supervised to detect I/O function failures. It shall provide for operation as a device connected to the system via the manufacturers control network.

##### 2.12.3.1 Integral Features

The universal programmable controller shall include as a minimum:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and if necessary power supply.
- d. Manufacturers control network port.
- e. I/O functions
  - (1) 8 DI
  - (2) 4 DO
  - (3) 8 AI
  - (4) 4 AO
  - (5) 1 PA
- f. On-Off-Auto switches for each DO which controls a device. These



switches shall be mounted in the universal programmable controller, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.

#### 2.12.3.2 Communication Interfaces

The UPC shall have the following communication capabilities which shall function simultaneously.

a. Manufacturers Control Network. The manufacturers control network communications interface for a data transmission systems (DTS) circuit between the UPC and a network control panels shall be provided. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the UPC Panel enclosure.

b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. A UPC workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel.

#### 2.12.3.3 Memory and RTC Backup

The UPC memory and real time clock functions shall continue to operate for a minimum of 72 hours in the event of a power failure. If rechargeable batteries are provided, automatic charging of batteries shall be provided. Whenever a either a permanent workstation/tester or portable workstation/tester is monitoring the network control panel, a low battery alarm message shall be sent to it.

#### 2.12.3.4 Specific Requirements

Each universal programmable controller shall be accessible for purposes of application selection, control parameters, set point adjustment, and monitoring from any DDC controller connected to the same manufacturers control network as the universal programmable controller. This shall be done using a portable workstation/tester connected to a portable workstation/tester port either directly or via modem.

#### 2.12.3.5 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each enclosure.

#### 2.12.3.6 Failure Mode

Upon failure of the universal programmable controller, it shall revert to the failure mode of operation as shown.

#### 2.12.4 Unitary Controller

The unitary controller shall be a microprocessor based, stand-alone, dedicated purpose controller, communicating with the network control panel, designed and programmed to control air distribution system mixing boxes, terminal units, heat pumps, fan coil units, self-contained DX units or VAV boxes as shown. Each unitary controller shall contain resident programs in

nonvolatile memory for each specific application implemented. Each unitary controller shall contain necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide control and monitoring of connected equipment and devices. It shall contain all necessary I/O functions to connect to field sensors and controls. I/O operation shall be fully supervised to detect I/O function failures and shall provide for operation as a device connected to the network control panel via the manufacturers control network.

#### 2.12.4.1 Integral Features

The unitary controller shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and power supply.
- d. Manufacturers control network port.
- e. All I/O functions required to implement the requirements as shown.
- f. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the field panel, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.

#### 2.12.4.2 Communication Interfaces

The unitary controller shall have the following communication capabilities which shall function simultaneously.

a. Manufacturers Control Network. The manufacturers control network communications interface for a data transmission systems (DTS) circuit between the unitary controller and a network control panel shall be provided. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the unitary control panel enclosure.

b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. A unitary controller workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel. For unitary controller applications where the controller is not mounted in an enclosure, such as for fan-coil units or VAV terminal units, a portable conversion device for an RS-232 connection to the portable workstation/tester may be provided.

#### 2.12.4.3 Specific Requirements

Unitary controller components for air distribution terminal units shall be furnished to the air distribution terminal unit manufacturer for factory mounting and calibration.

- a. Accessibility and Interfaces: Each unitary controller shall be

accessible for purposes of application selection, control parameters, set point adjustment, and monitoring using a portable workstation/tester connected to the manufacturers control network. They shall also be accessible with a portable workstation/tester connected to the unitary controller portable workstation/tester port.

b. Air Distribution Terminal Unit Controls - Pressure Independent: Controls shall consist of a transducer for connection to the velocity-sensing device provided by the terminal unit supplier in the primary air entering the terminal unit, a room temperature sensor, a damper actuator, and an adjustable microprocessor-based controller. The room temperature sensor shall have occupant setpoint adjustment and temperature display, timed override of unoccupied mode, and a communication port. The controller shall operate the damper for cooling and heating and provide control outputs for duct heating coil if applicable. This controller capability shall allow the sequencing of the damper and the heating coil to maintain conditions in the space.

c. Air Distribution Terminal Unit Damper Actuator: Air distribution terminal unit damper actuator shall open or close the device to which it is connected within 60 seconds. The damper actuator shall utilize spring return to fail to the position shown on loss of power or control signal.

#### 2.12.4.4 Failure Mode

Upon failure of the unitary controller, it shall revert to the failure mode of operation as shown.

#### 2.12.5 Chiller Control Panel

Chiller control panel shall be microprocessor-based and shall provide, both locally and through the Manufacturers Control Network, the control, monitoring, and safety equipment functions provided by the chiller manufacturer's control panel(s) (two communications ports total). The chiller control panel instrumentation and control ranges and accuracies shall match those of the chiller manufacturer's control devices. The chiller panel shall have a communication port for interface to a Portable Workstation/Tester through either the Manufacturers Control Network or modem for chiller(s) start/stop, chilled water temperature reset, and monitoring of chiller operating status, alarms, and power consumption.

#### 2.12.6 Boiler Control Panel

Boiler control panel shall be microprocessor-based and shall provide, both locally and through the Manufacturers Control Network, the control, monitoring, and safety equipment functions provided by the boiler manufacturer's control panel(s) (two communications ports total). The boiler control panel instrumentation and controls ranges and accuracies shall match those of the boiler manufacturer's control devices. The boiler panel shall have a communication port for interface to a Portable Workstation/Tester through either the Manufacturers Control Network or modem for boiler(s) and start/stop, boiler water temperature reset, and monitoring of boiler operating status, alarms.

#### 2.12.7 I/O Functions

##### 2.12.7.1 DDC Hardware I/O Functions

I/O Functions shall be provided as part of the DDC system and shall be in

accordance with the following:

a. The analog input (AI) function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. The A-to-D conversion shall have a minimum resolution of 10 bits plus sign. Signal conditioning shall be provided for each analog input. Analog inputs shall be individually calibrated for zero and span, in hardware or in software. The AI shall incorporate common mode noise rejection of 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of 20 dB at 60 Hz from a source impedance of 10,000 ohms. Input ranges shall be within the range of 4-to-20 mAdc.

b. The analog output (AO) function shall accept digital data, perform D-to-A conversion, and output a signal within the range of 4-to-20 mAdc. D-to-A conversion shall have a minimum resolution of eight bits plus sign. Analog outputs shall be individually calibrated for zero and span. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided.

c. The digital input (DI) function shall accept on-off, open-close, or other change of state (two state data) indications. Isolation and protection against an applied steady-state voltage up to 180 Vac peak shall be provided.

d. The digital output (DO) function shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second. DO relays shall have an initial breakdown voltage between contacts and coil of at least 500 V peak. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to nondamaging levels. Protection against an applied steady-state voltage up to 180 Vac peak shall be provided. Minimum contact rating shall be one ampere at 24 Vac.

e. The pulse accumulator function shall have the same characteristics as the DI. In addition, a buffer shall be provided to totalize pulses and allow for interrogation by the DDC system. The pulse accumulator shall accept rates up to 20 pulses per second. The totalized value shall be reset to zero upon operator's command.

f. Signal conditioning for sensors shall be provided as specified.

g. The binary coded decimal (BCD) function: The BCD function shall have the same characteristics as the DI, except that, in addition, a buffer shall be provided to totalize inputs and allow for interrogation by the network control panel. The BCD function shall have 16-channel optically isolated buffered inputs to read four digit numbers. The BCD function shall accumulate inputs at rates up to 10 inputs per second.

#### 2.12.7.2 Failure Mode

Upon failure of the I/O function, including data transmission failure, logic power supply failure, DDC processor malfunction, software failure, interposing relay power failure, or any other failure which prevents stand alone operation of any DDC normally capable of stand alone operation, connected outputs shall be forced to the failure mode shown.

#### 2.12.8 Portable Workstation/Tester

A portable workstation/tester shall be provided and shall be able to

connect to any DDC hardware. The portable workstation/tester shall consist of a portable computer with a nominal 10 inch active color matrix liquid crystal display, capable of displaying up to 256 colors at a minimum resolution of 640 X 480 pixels, an external VGA monitor port, 32 bit microprocessor operating at a minimum of 100 MHZ. The portable workstation/tester shall have, as a minimum, a 1200 MB hard drive, 16 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, 3.5 inch floppy disk drive, modem, PCMCIA type 3 slot, rechargeable battery, battery charger and 120 Vac power supply. It shall include carrying case, extra battery, charger and a compatible network adapter. The workstation/tester shall:

- a. Run DDC diagnostics.
- b. Load all DDC memory resident programs and information, including parameters and constraints.
- c. Display any AI, DI, AO, DO, or PA point in engineering units for analog points or status for digital points.
- d. Control any AO or DO.
- e. Provide an operator interface, contingent on password level, allowing the operator to use full English language words and acronyms, or an object oriented graphical user interface.
- f. Display database parameters.
- g. Modify database parameters.
- h. Accept DDC software and information for subsequent loading into a specific DDC. Provide all necessary software and hardware required to support this function, including an EIA ANSI/EIA/TIA-232-F port.
- i. Disable/enable each DDC.
- j. Perform all workstation functions as specified.

#### 2.12.9 Central Workstation/Tester

A central workstation/tester shall be provided and shall be able to communicate any network control panel via the primary network. The central workstation/tester shall be functionally equivalent to the portable workstation/tester but is intended to be a stationary unit. The central workstation/tester shall consist of a central computer with a nominal 14 inch VGA color display, capable of displaying up to 256 colors at a minimum resolution of 640 X 480 pixels, 32 bit microprocessor operating at a minimum of 100 MHZ. The central workstation/tester shall have, as a minimum, a 2100 MB hard drive, 32 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, 3.5 inch floppy disk drive, modem, PCMCIA type three slot, rechargeable battery, battery charger, 120 Vac power supply and network adapter (Ethernet IEEE802.3 or ARCNET). The central workstation/tester shall:

- a. Run DDC diagnostics.
- b. Load all DDC memory resident programs and information, including parameters and constraints.

c. Display any AI, DI, AO, DO, or PA point in engineering units for analog points or status for digital points.

d. Control any AO or DO.

e. Provide an operator interface, contingent on password level, allowing the operator to use full English language words and acronyms, or an object oriented graphical user interface.

f. Display database parameters.

g. Modify database parameters.

h. Accept DDC software and information for subsequent loading into a specific DDC. Provide all necessary software and hardware required to support this function, including an EIA ANSI/EIA/TIA-232-F port.

i. Disable/enable each DDC.

j. Perform all workstation functions as specified.

## 2.13 DDC SOFTWARE

All DDC software described in this specification shall be furnished as part of the complete DDC System.

### 2.13.1 Operating System

Each DDC shall contain an operating system that controls and schedules that DDC's activities in real time. The DDC shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that DDC. The execution of DDC application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each DDC real time clock shall be automatically synchronized with the network control panel real time clock at least once per day to plus or minus 10 seconds. When the network control panel is connected to a central workstation/tester, the network control panel RTC shall be updated by the central workstation/tester RTC. The time synchronization shall be accomplished without operator intervention and without requiring system shutdown. The operating system shall allow loading of software, data files data entry, and diagnostics from the central workstation/tester both locally through the central workstation/tester port and remotely through a network control panel and the manufacturers control network.

#### 2.13.1.1 Startup

The DDC shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A DDC restart program based on detection of power failure at the DDC shall be included in the DDC software. Upon restoration of power to the DDC, the program shall restart equipment and restore loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the DDC, if the database and

application software are no longer resident or if the clock cannot be read, the DDC shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the database and application programs are resident, the DDC shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each DDC shall include a unique time delay setting for each control output when system operation is initiated.

#### 2.13.1.2 Operating Mode

Each DDC shall control and monitor functions as specified, independent of communications with other DDC. This software shall perform all DDC functions and DDC resident application programs as specified using data obtained from I/O functions and based upon the DDC real time clock function. When communications circuits between the DDC are operable, the DDC shall obtain real time clock updates and any required global data values transmitted from other network control panels. The DDC software shall execute commands after performing constraints checks in the DDC. Status and analog values, including alarms and other data shall be transmitted from other network control panels when communications circuits are operable. If communications are not available, each DDC shall function in stand-alone mode and operational data, including the latest status and value of each point and results of calculations, normally transmitted from other network control panels shall be stored for later transmission to the network control panel. Storage for the latest 256 values shall be provided at each network control panel. Each DDC shall accept software downloaded from the network control panel. Constraints shall reside at the DDC.

#### 2.13.1.3 Failure Mode

Upon failure for any reason, each DDC shall perform an orderly shutdown and force all DDC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

#### 2.13.2 Functions

The Contractor shall provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each network control panel, RIU, unitary controller and universal programmable controller.

- a. Scanning of inputs.
- b. Control of outputs.
- c. Reporting of analog changes outside a selectable differential.
- d. Reporting of unauthorized digital status.
- e. Reporting of alarms automatically to network control panel.
- f. Reporting of I/O status to network control panel upon request.
- g. Maintenance of real time, updated by the network control panel at least once a day.
- h. Communication with the network control panel.
- i. Execution of DDC resident application programs.

- j. Averaging or filtering of AIs.
- k. Constraints checks (prior to command issuance).
- l. Diagnostics.
- m. Portable workstation/tester operation as specified.
- n. Reset of PA by operator based on time and value.

#### 2.13.2.1 Analog Monitoring

The system shall measure and transmit analog values including calculated analog points. An analog change in value is defined as a change exceeding a preset differential value as specified. The record transmitted for each analog value shall include a readily identifiable flag which indicates the abnormal status of the value when it deviates from operator selectable upper and lower analog limits. Analog values shall be expressed in proper engineering units with sign. Engineering units conversions shall be provided for each measurement. Each engineering units conversion set shall include range, span, and conversion equation. A vocabulary of engineering unit descriptors shall be provided, using at least three alphanumeric characters to identify information in the system. The system shall support 255 different engineering units.

#### 2.13.2.2 Logic (Virtual) Points

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database by the Contractor. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Constants used in calculations shall be changeable on-line by the operator. Calculated point values shall be current for use by the system within 10 seconds of the time of any input changes.

#### 2.13.2.3 State Variables

If an analog point represents more than two (up to eight) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

#### 2.13.2.4 Analog Totalization

Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period. At the end of the period, the totals shall be stored. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to set or reset each totalized value individually. The time period shall be



able to be operator defined, modified or deleted on-line.

#### 2.13.2.5 Energy Totalization

The system shall calculate the heat energy in Btus, for each energy source consumed by the mechanical systems specified, totalize the calculated Btus, the instantaneous rate in Btus per hour, and store totals in thousands of Btus (MBtu). The Btus calculated shall be totalized for an adjustable time period. The time period shall be defined uniquely for each Btu totalization.

#### 2.13.2.6 Trending

Any analog or calculated point shall be operator assignable to the trend program. Up to eight points shall be sampled at individually assigned intervals, selectable between one minute and two hours. A minimum of the most recent 128 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted on-line.

#### 2.13.3 I/O Point Database/Parameter Definition

Each I/O point shall be defined in a database residing in the DDC. The definition shall include all physical parameters associated with each point. Each point shall be defined and entered into the database by the Contractor, including as applicable:

- a. Name.
- b. Device or sensor type (i.e., sensor, control relay, motors).
- c. Point identification number.
- d. Unit.
- e. Building number.
- f. Area.
- g. Island.
- h. DDC number and channel address.
- i. KW (running).
- j. KW (starting).
- k. Sensor range.
- l. Controller range.
- m. Sensor span.
- n. Controller span.
- o. Engineering units conversion (scale factor).
- p. Setpoint (analog).
- q. High reasonableness value (analog).

- r. Low reasonableness value (analog).
- s. High alarm limit differential (return to normal).
- t. Low alarm limit differential (return to normal).
- u. High alarm limit (analog).
- v. Low alarm limit (analog).
- w. Alarm disable time period upon startup or change of setpoint.
- x. Analog change differential (for reporting).
- y. Alarm class and associated primary message text.
- z. High accumulator limit (pulse).
- aa. Status description.
- bb. Run time target.
- cc. Failure mode as specified and shown.
- dd. Constraints as specified.

#### 2.13.4 Alarm Processing

Each DDC shall have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that DDC.

##### 2.13.4.1 Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by DIs as specified and shown.

##### 2.13.4.2 Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. Analog alarm limits shall be stored in the DDC database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return into the proper operating range before being annunciated as a return-to-normal-state. All limits and differentials shall be entered on-line by the operator in limits of the measured variable, without interruption or loss of monitoring of the point concerned. The program shall automatically change the high or low limits or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the alarm limit becomes effective. In CPA applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with a digital point when that digital point is turned off.

#### 2.13.4.3 Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system. Limits shall be stored in the DDC database.

#### 2.13.5 Constraints

##### 2.13.5.1 Equipment Constraints Definitions

Each control point in the database shall have DDC resident constraints defined and entered by the Contractor, including as applicable:

- a. Maximum starts (cycles) per hour.
- b. Minimum off time.
- c. Minimum on time.
- d. High limit (value in engineering units).
- e. Low limit (value in engineering units).

##### 2.13.5.2 Constraints Checks

Control devices connected to the system shall have the DDC memory resident constraints checked before each command is issued to insure that no equipment damage will result from improper operation. Each command shall be executed by the DDC only after all constraints checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Values outside the reasonableness limits shall be rejected and an alarm message sent to the network control panel or portable workstation/tester. Status changes and analog point values shall be reported to the workstation upon operator request, such as for reports, alphanumeric displays, graphic displays, and application programs. Each individual point shall be capable of being selectively disabled by the operator from a workstation/tester. Disabling a point shall prohibit monitoring and automatic control of that point.

#### 2.13.6 Diagnostics

Each DDC shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be usable in conjunction with the central workstation/tester and portable workstation/tester. The software shall display messages in English to inform the tester's operator of diagnosed problems.

#### 2.13.7 Summer-Winter Operation Monitoring

The system shall provide software to automatically change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system from summer to winter and vice-versa. The software shall provide automatic commands to applications programs to coordinate proper summer or winter operation. Change over setpoints shall be operator selectable and settable.

### 2.13.8 Control Sequences and Control Loops

Sufficient memory shall be provided to implement the requirements specified and shown for each DDC. Specific functions to be implemented are defined in individual system control sequences and database tables shown in the drawings, and shall include, as applicable, the following:

a. PI Control: This function shall provide proportional control and proportional plus integral control.

b. Two Position Control: This function shall provide control for a two state device by comparing a set point against a process variable and an established deadband.

c. Floating Point Control: This function shall exercise control when an error signal exceeds a selected deadband, and shall maintain control until the error is within the deadband limits.

d. Signal Selection: This function shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control. The function shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs.

e. Signal Averaging: This function shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control. The function shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control.

f. Reset Function: This function shall develop an AO based on up to two AIs and one operator specified reset schedule.

g. Cooling/Heating Operation Program: Software shall be provided to change, either automatically or on operator command, the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system where such a change from cooling to heating and vice versa is meaningful. The software shall provide commands to application programs to coordinate cooling or heating mode operation. Software shall automatically switch facilities from cooling to heating, and vice versa, based on schedules or temperatures. All HVAC equipment and systems shall be assigned to the program.

### 2.13.9 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the on and off states, insuring that the correct command shall be issued when the time constraint is no longer in effect or report the rejected command. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

### 2.13.10 Resident Application Software

The Contractor shall provide resident applications programs to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the DDC system. Application

programs shall be resident and shall execute in the DDC, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved. The Contractor shall coordinate the application programs specified with the equipment and controls operation, and other specified requirements. A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the ON and OFF states, insuring that the correct command shall be issued when the time constraint is no longer in effect or the rejected command shall be reported. Override commands entered by the operator shall have higher priority than those emanating from application programs.

#### 2.13.10.1 Program Inputs and Outputs

The Contractor shall select the appropriate program inputs listed for each application program to calculate the required program outputs. Where the specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate. AIs to application programs shall have an operator adjustable deadband to preclude short cycling or hunting. Program outputs shall be real analog or digital outputs or logic (virtual) points as required to provide the specified functions. The Contractor shall select the appropriate input and output signals to satisfy the requirements for control of systems as shown.

#### 2.13.10.2 DDC General Conditions

The Contractor shall provide software required to achieve the sequences of operation, parameters, constraints, and interlocks shown. Application software shall be resident in the DDC in addition to any other required software. In the event of a DDC failure, the controlled equipment shall continue to function in the failure mode shown.

#### 2.13.10.3 Scheduled Start/Stop Program

This program shall start and stop equipment based on a time of day schedule for each day of the week, and on a holiday schedule. To eliminate power surges, an operator adjustable time delay shall be provided between consecutive start commands.

##### a. Program Inputs:

- (1) Day of week/holiday.
- (2) Time of day.
- (3) Cooling and heating high-low alarm limits.
- (4) Cooling and heating start-stop schedules.
- (5) Cooling or heating mode of operation.
- (6) Equipment status.
- (7) Equipment constraints.

(8) Consecutive start time delay.

b. Program Outputs: Start/stop signal.

#### 2.13.10.4 Optimum Start/Stop Program

This program shall start and stop equipment as specified for the scheduled start/stop program, but shall include a sliding schedule based on indoor and outdoor air conditions. The program shall take into account the thermal characteristics of the structure, and indoor and outdoor air conditions, using prediction software to determine the minimum time of HVAC system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end without exceeding space environmental requirements. An adaptive control algorithm shall be utilized to automatically adjust the constants used in the program.

a. Program Inputs:

- (1) Day of week/holiday.
- (2) Time of day.
- (3) Cooling or heating mode of operation.
- (4) Equipment status.
- (5) Cooling and heating building occupancy schedules.
- (6) Space temperature.
- (7) Building heating constant (operator adjustable and automatically optimized).
- (8) Building cooling constant (operator adjustable and automatically optimized).
- (9) OA temperature.
- (10) Required space temperature at occupancy (heating).
- (11) Required space temperature at occupancy (cooling).
- (12) Equipment constraints.
- (13) Cooling and heating high-low alarm limits.

b. Program Outputs: Start/stop signal.

#### 2.13.10.5 Day-Night Setback Program

The software shall limit the rise or drop of space temperature (or specified fluid temperature) during unoccupied hours. Whenever the space temperature (or specified fluid temperature) is above (or below for heating) the operator assigned temperature limit, the system shall be turned on until the temperature is within the assigned temperature limit.

a. Program Inputs:

- (1) Day of week.
- (2) Time of day.
- (3) Cooling or heating mode of operation.
- (4) Cooling and heating occupancy schedules.
- (5) Equipment status.
- (6) Space temperature (or specified fluid temperature).
- (7) Minimum space temperature (or specified fluid temperature) during unoccupied periods.
- (8) Maximum space temperature (or specified fluid temperature) during unoccupied periods.
- (9) Equipment constraints.

b. Program Outputs: Start/stop signal.

#### 2.13.10.6 Ventilation/Recirculation Programs

The software shall reduce the HVAC system thermal load for two modes of operation and provide for flushing of the building as follows:

a. Ventilation mode: In this mode, the system shall precool the space prior to building occupancy. When the outside air temperature is lower than the space temperature, the outside air damper and exhaust air damper shall open to their maximum positions and the return air damper shall close to its minimum position.

b. Recirculation mode: In this mode, the system shall preheat the space prior to building occupancy. When the outside air temperature is lower than the space temperature, the outside air damper and the exhaust air damper shall close to their minimum positions and the return air damper shall open to its maximum position.

c. Program Inputs:

- (1) Day of week.
- (2) Time of day.
- (3) Cooling or heating mode of operation.
- (4) Equipment status.
- (5) Cooling and heating occupancy schedules.
- (6) OA dry bulb temperature.
- (7) Space temperature.
- (8) Equipment constraints.

d. Program Output: Damper actuator control signal.

## 2.13.10.7 Reheat Coil Reset Program

The software shall select the zone with the least amount of heat required. The program shall reset the cold deck discharge temperature upward until it satisfies the zone with the lowest demand, or until the zone humidity control requirements cannot be met.

## a. Program Inputs:

- (1) Zone RH high limit.
- (2) Zone temperature (where shown).
- (3) Zone RH (where shown).
- (4) Cold deck temperature.
- (5) Reheat coil valve positions or proportional signals from primary elements.
- (6) Minimum space temperature during occupied periods.
- (7) Maximum space temperature during occupied periods.
- (8) Equipment constraints.

## b. Program Output: Cold deck valve actuator control signal.

## 2.13.10.8 Air Volume Control Program

The software shall monitor supply and return air flow volumes and modulate fan controls to maintain required air flow volumes and/or ratio or fixed differential of supply to return air flows. This program shall be coordinated with the ventilation-recirculation program and the economizer program for damper control and with static pressure control requirements for fan control.

## a. Program Inputs

- (1) Supply air flow.
- (2) Return/exhaust air flow.
- (3) Required supply air flow - high and low limits.
- (4) Required return/exhaust air flow - high and low limits.
- (5) Volume offset or ratio, as appropriate.

## b. Program Outputs

- (1) Supply fan volume control.
- (2) Return/exhaust fan volume control.

## 2.13.10.9 Air Distribution Unitary Controller Software

Software shall be provided for the management and control of the air distribution terminal units. Software shall allow for operator definition of multiple air distribution terminal units as functional groups which may be treated as a single entity; monitoring, alarming and reporting of terminal unit parameters on an individual or group basis; and remote setpoint adjustment on an individual or group basis.



## a. Functions:

- (1) Volume control in response to temperature.
- (2) Volume flow limits, minimum and maximum.
- (3) Occupied and unoccupied operation with associated temperature and volume limits.
- (4) Temperature setpoint override.

## b. Program Inputs

- (1) Space temperature.
- (2) Space temperature setpoint.
- (3) Space temperature setpoint limits.
- (4) Supply airflow volume.
- (5) Supply airflow volume high and low limits.

## c. Program Outputs

- (1) Supply volume control signal.
- (2) Auxiliary fan start/stop signal.
- (3) Supplemental heat control signal.

## 2.13.10.10 Chiller Selection Program

Chiller program shall be used for chiller control and monitoring. The program shall calculate equipment electrical energy input based on percent full load, current, or other inputs provided, and equipment nameplate data.

The program shall prevent the chiller from going to full load for a predetermined period to allow the system to stabilize, in order to determine the actual cooling load. The program shall follow the chiller manufacturer's startup and shutdown sequence requirements. Interlocks between chilled water pumps, and chiller shall be in accordance with the chiller manufacturer's requirements.

## a. Program Inputs

- (1) Efficiency curves.
- (2) Chiller water supply temperatures.
- (3) Chiller water return temperatures.
- (4) Chiller water flows.
- (5) Instantaneous KW to chillers.
- (6) Chilled water supply temperatures.
- (7) Chilled water return temperatures.
- (8) Total chilled water flow.
- (9) Chilled water pumps status.
- (10) Refrigerant pressure, suction and discharge.
- (11) Equipment constraints.

## b. Program Outputs

- (1) Start/stop signals for chillers (manual or automatic to control panel).
- (2) Start/stop signals for chilled water pumps (manual or automatic to control panel).
- (3) Chilled water supply temperature setpoint control signal.
- (4) Chiller efficiency.

## 2.13.10.11 Chilled Water Temperature Reset Program

The software shall reset the chilled water temperature supplied by a water chiller. The program shall reset the chilled water temperature upward or downward to meet the required space temperature or humidity setpoints. The program shall monitor the positions of the chilled water control valves (percent of opening) and space temperatures.

## a. Program Input:

- (1) Chilled water valve position.
- (2) High limit for space dry bulb temperature.
- (3) Chiller supply water temperature.
- (4) High chilled water operating temperature.
- (5) Low chilled water operating temperature.
- (6) High limit for space RH.
- (7) Equipment constraints.

b. Program Output: Chilled water supply temperature setpoint control signal.

## 2.13.10.12 Chiller Demand Limit Program

The software shall limit maximum available chiller cooling capacity in fixed steps as shown to limit electrical demand. Each fixed step shall be considered as one point in the demand limiting program. Each chiller demand control step shall be assigned an equipment priority level.

## a. Program Inputs:

- (1) Chiller percent capacity.
- (2) Minimum cooling capacity.
- (3) Equipment priority schedules.
- (4) Equipment constraints.

## b. Program Output

- (1) Calculated percent load point.
- (2) Control signal to chiller controller/panel, new setpoint (manual or automatic as shown).

## 2.13.10.13 Hot Water OA Reset Program

The boiler shall be provided with its own reset program.

## 2.13.10.14 Domestic Hot Water Generator Program

The software shall control the domestic hot water temperature by adjusting the hot water heating control valve.

## a. Program Inputs

- (1) Domestic hot water temperature.
- (2) Domestic hot water temperature setpoint.

b. Program Output: Hot water heating control valve actuator control signal.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION CRITERIA

#### 3.1.1 HVAC Control System

The HVAC control system shall be completely installed and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

#### 3.1.2 Software Installation

Software shall be loaded for an operational system, including databases for all points, operational parameters, and system, command, and application software. The Contractor shall provide original and backup copies of source, excluding the general purpose operating systems and utility programs furnished by computer manufacturers and the non-job-specific proprietary code furnished by the system manufacturer, and object modules for software on each type of media utilized, within 30 days of formal Government acceptance. In addition, a copy of individual floppy disks of software for each DDC panel shall be provided.

#### 3.1.3 Device Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

#### 3.1.4 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. Nonmetallic-sheathed cables or metallic-armored cables may be installed in areas permitted by NFPA 70. Wiring shall be installed without splices between control devices and DDC panels. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Electrical work shall be as specified in Section 16415A ELECTRICAL WORK, INTERIOR and as shown.

### 3.2 CONTROL SYSTEM INSTALLATION

#### 3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators

operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

### 3.2.2 Room Instrument Mounting

Room instruments , such as wall mounted thermostats, shall be mounted 54 inches above the floor unless otherwise shown. Temperature setpoint devices shall be recess mounted.

### 3.2.3 Freezestats

For each 20 square feet of coil face area, or fraction thereof, a freezestat shall be provided to sense the temperature at the location shown. Manual reset freezestats shall be installed in approved, accessible locations where they can be reset easily. The freezestat sensing element shall be installed in a serpentine pattern.

### 3.2.4 Averaging Temperature Sensing Elements

Sensing elements shall have a total element minimum length equal to 1 linear foot per square foot of duct cross-sectional area.

### 3.2.5 Foundations and Housekeeping Pads

Foundations and housekeeping pads shall be provided for the HVAC control system air compressors.

### 3.2.6 Duct Static Pressure Sensing Elements and Transmitters

The duct static pressure sensing element and transmitter sensing point shall be located at 75% to 100% of the distance between the first and last air terminal units.

### 3.2.7 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

## 3.3 CONTROL SEQUENCES OF OPERATION

Shall be as indicated on the Drawings.

## 3.4 COMMISSIONING PROCEDURES

### 3.4.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, set the time schedule, and make any necessary control system corrections to ensure that the systems function as described in the sequence of operation.

#### 3.4.1.1 Item Check

Signal levels shall be recorded for the extreme positions of each controlled device. An item-by-item check of the sequence of operation

requirements shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shut down; Step 4 shall be performed after the HVAC systems have been started. External input signals to the DDC system (such as starter auxiliary contacts, and external systems) may be simulated in steps 1, 2, and 3. With each operational mode signal change, DDC system output relay contacts shall be observed to ensure that they function.

#### 3.4.1.2 Weather Dependent Test Procedures

Weather dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.

#### 3.4.1.3 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the DDC system readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-DDC system readout accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-DDC system readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

#### 3.4.1.4 Insertion and Immersion Temperatures

Insertion temperature and immersion temperature sensing elements and transmitter-to-DDC system readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

#### 3.4.1.5 Averaging Temperature

Averaging temperature sensing element and transmitter-to-DDC system readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

#### 3.4.2 Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space thermostat temperature setting shall be turned up so that it makes contact to turn on the unit heater fans. The unit heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. It shall be ensured that the unit heater fans start. Each space thermostat temperature setting shall be turned down, and the unit heater fans shall stop. The thermostats shall be set at their temperature setpoints. The results of testing of one of each type of unit shall be logged.

### 3.4.3 All-Air Small Packaged Unitary

The schedules shall be manually entered for day temperature and night temperature setpoints as shown. The fan "AUTO/ON" switch shall be set to "ON." The time shall be manually entered as "DAY." The "HEATING/COOLING" switch shall be set to "HEATING" and it shall be ensured that cooling is off. The temperature setpoint shall be raised and it shall be ensured that heating starts. The "HEATING/COOLING" switch shall be set to "COOLING" and it shall be ensured that heat is off. The temperature setpoint shall be lowered and it shall be ensured that cooling starts. The fan "AUTO/ON" switch shall be set to "AUTO" and the foregoing procedure repeated. The fan shall start and stop automatically with the starting and stopping of heating and cooling. The time shall be manually entered as "NIGHT." The foregoing procedures shall be repeated. When the system is verified as operational, the correct "DAY" and "NIGHT" temperature settings shall be restored and the correct time restored. The power to the thermostat shall be shut off and it shall be verified that the thermostat clock keeps time. The results of testing of one of each type of unit shall be logged.

### 3.4.4 Fan Coil Unit

The dual-temperature hydronic system shall be set to heating. Each space thermostat temperature setting shall be turned up so that it makes contact and turns the fan coil unit on. It shall be ensured that the fan coil unit fan starts and the valves open to flow through the coils. Each space thermostat temperature setting shall be turned down and it shall be ensured that the fan coil unit fans stop. It shall be ensured that the valves close to flow through the coils. The dual-temperature hydronic system shall be switched to cooling. Each space thermostat temperature setting shall be turned up and it shall be ensured that contact is broken and the fan coil unit fans stop. It shall be ensured that the valves close to flow through the coil. Each space thermostat temperature setting shall be turned down. It shall be ensured that the fan coil unit fans start and the valves open to flow through the coils. The thermostats shall be set at their temperature setpoints. The results of testing of one of each type of unit shall be logged.

### 3.4.5 Single Building Hydronic Heating with Hot Water Boiler

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power and main air are available where required.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each temperature shall be read at the DDC controller, and the thermometer and DDC system readings logged. The calibration accuracy of the sensing element-to-DDC system readout for outside air temperature and system supply temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator through an operator entered value to the DDC system. The proper operation of the actuators and positioners for all valves shall be verified visually. The signal shall be varied from live zero to full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper

direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

(1) The two-point calibration sensing element-to-DDC system readout accuracy check for the outside air temperature shall be performed. Any necessary software adjustments to setpoints or parameters shall be made to achieve the outside air temperature schedule.

(2) The outside air temperature shall be simulated through an operator entered value to be above the setpoint. It shall be verified that pumps and boilers stop. A value shall be entered to simulate that the outside air temperature is below the setpoint as shown. It shall be verified that pumps start and boiler operates.

(3) The two-point calibration accuracy check of the sensing element-to-DDC system readout for the hydronic system supply temperature shall be performed. The supply temperature setpoint shall be set for the temperature schedule as shown. Signals of 8 ma and 16 ma shall be sent to the DDC system from the outside air temperature sensor, to verify that the supply temperature setpoint changes to the appropriate values.

(4) The control system shall be placed in the occupied mode. The calibration accuracy check of sensing element-to-DDC system readout shall be performed for each space temperature sensor and the values logged. Each space temperature setpoint shall be set as shown. The control system shall be placed in the unoccupied mode, and it shall be verified that each space temperature setpoint changes to the unoccupied mode setting.

3.4.6 Single Building Chilled Water System

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power is available where required.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each temperature shall be read at the DDC controller, and the thermometer and DDC system readings logged. The calibration accuracy of the sensing element-to-DDC system readout for outside air temperature, hydronic system supply and return temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, through an operator entered value. The proper operation of the actuators and positioners for all valves shall be visually verified. The signal shall be varied from live zero to full range, and actuator travel from zero stroke to full stroke within the signal range shall be verified. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

- (1) The two-point calibration sensing element-to-DDC system readout accuracy check for the outside air temperature shall be performed. Any necessary software adjustments shall be made to setpoints or parameters to achieve the outside air temperature schedule.
- (2) The control system shall be indexed to the heating mode and it shall be verified that the chillers are shut down and that chilled water pumps stop.
- (3) The two-point calibration accuracy check of the sensing element-to-DDC system readout for the chilled water system supply temperature shall be performed. The supply temperature setpoint shall be set for the temperature schedule as shown. Signals of 8 ma and 16 ma shall be sent to the DDC system from the outside air temperature sensor, to verify that the supply temperature setpoint changes to the appropriate values.
- (4) The two-point accuracy check of sensing element-to-DDC system readout for the hydronic system return temperature shall be performed. It shall be verified that the return water temperature setpoint is set to the setpoint. The control system shall be placed in the unoccupied mode.
- (5) The control system shall be indexed to the cooling mode. It shall be verified that boiler shuts down.
- (6) The control system shall be placed in the occupied mode and it shall be verified that chilled water pumps start and chiller operation is enabled.
- (7) The control system shall be placed in the off mode and it shall be verified that chillers shut down and chilled water pumps stop. WCU-HQ-Z system shall be checked to insure that it operates any time emergency power is engaged.

#### 3.4.7 Variable Air Volume Control System - Without Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. The system shall be checked to see that power and main air are available where required, the outside air and relief air dampers are closed, the return air damper is open, and the supply fan inlet vanes and cooling coil valve are closed.

b. Step 2 - Calibration Accuracy Check with HVAC System in Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each temperature shall be read at the DDC controller, and the thermometer and DDC system display readings logged. The calibration accuracy of the sensing element-to-DDC system readout for outside air, return air, mixed air, and the cooling coil discharge temperatures shall be checked. The minimum outside air flow shall be read, using a digital indicating velometer, and the velometer and DDC system display readings logged. The flow should read zero.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuators through an operator entered value to the DDC system. The



proper operation of the actuators and positioners for all dampers and valves shall be visually verified. The signal shall be varied from live zero to full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

(1) With the fan ready to start, the control system shall be placed in the ventilation delay mode and in the occupied mode through operator entered values. It shall be verified that supply fans start. It shall be verified that the outside air dampers are closed, the return air damper is open, and the cooling coil valve and variable frequency drives are under control, by simulating a change in the fan discharge temperature. The system shall be placed out of the ventilation delay mode, and it shall be verified that the economizer outside air and relief air dampers remain closed, the return air damper remains open, and the minimum outside air damper comes under control.

(2) The two-point calibration accuracy check of sensing element-to-DDC system readout for the minimum outside air flow measurement station shall be performed. Force all VAV box dampers to the full open position, turn all exhaust fans off, manually adjust the supply duct static pressure to achieve the design duct static pressure, and manually adjust the minimum outside air flow to achieve a flow which is approximately 25% less than the desired air flow. Under these conditions, the minimum outside air flow control loop shall be tuned. Confirm stable operation of the minimum outside air flow control loop in response to a process disturbance.

(3) With supply fan running, a high static pressure input signal shall be simulated at the device, by pressure input to the differential pressure switch sensing device. HVAC system shutdown shall be verified; it shall be verified that the high static pressure alarm is initiated. The differential pressure switch shall be set at the setpoint. The HVAC system shall be restarted by manual reset, and it shall be verified that the high static pressure alarm returns to normal.

(4) The two-point calibration accuracy check for sensing element-to-DDC system readout for the static pressure in the supply duct shall be performed.

(5) The two-point calibration accuracy check of sensing element-to-DDC system readout for the fan discharge temperature shall be performed. The setpoint for the fan discharge temperature shall be set as shown. A change shall be simulated in the discharge air temperature through an operator entered value and it shall be verified that the control valve is modulated.

(6) The control system shall be placed in the unoccupied mode and it shall be verified that the HVAC system shuts down and the control system assumes the specified shutdown conditions. The space temperature shall be artificially changed to below the night setback temperature setpoint, and it shall be verified that the

HVAC system starts; the space temperature shall be artificially changed to above the night setback setpoint, and it shall be verified that the HVAC system stops. The night setback temperature setpoint shall be set at the setpoint shown.

(7) With the HVAC system running, a filter differential pressure switch input signal shall be simulated at the device. It shall be verified that the filter alarm is initiated. The differential pressure switch shall be set at the setpoint. This shall be performed for each filter.

(8) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified. It shall be verified that a low temperature alarm is initiated. The freezestat shall be set at the setpoint. The HVAC system shall be restarted by manual restart and it shall be verified that the alarm returns to normal.

(9) With the HVAC system running, a smoke detector trip input signal shall be simulated at each detector, and control device actions and interlock functions as described in the Sequence of Operation shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and the smoke detector alarm is initiated. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the alarm returns to normal.

(10) Velocity setpoints shall be set for minimum and maximum flow and temperature setpoints for the heating/cooling dead band, for each VAV terminal unit. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

#### 3.4.8 Single Zone with Hydronic Heating and Cooling Coils; No Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. The system shall be checked to see that power and main air are available where required, that the outside air damper, relief air damper, and cooling coil valve are closed, and that the return air damper is open.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each temperature shall be read at the DDC controller, and the thermometer and DDC system display readings logged. The calibration accuracy of the sensing element-to-DDC system readout for outside air, return air, and space temperatures shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator through an operator entered value to the DDC system. The proper operation of the actuators and positioners for all dampers and valves shall be visually verified. The signal shall be varied from live zero to full range, and the actuator travel from zero stroke to full stroke within the signal range shall be verified. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full

stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control System Commissioning:

(1) With the fan ready to start, the control system shall be placed in the ventilation delay mode and in the occupied mode, and it shall be verified that supply fans start. It shall be verified that the outside air and relief air dampers are closed, the return air damper is open, and the heating coil and cooling coil valves are under control, by simulating a change in the space temperature through an operator entered value. The control system shall be placed out of the ventilation delay mode, and it shall be verified that the outside air, return air, and relief air dampers come under control by simulating a change in the space temperature.

(2) The control system shall be placed in the minimum outside air mode. It shall be verified that the outside air damper opens to minimum position.

(3) The economizer mode shall be simulated by a change in the outside air temperature and the return air temperature through operator entered values and it shall be verified that the system goes into the economizer mode. The space temperature shall be artificially changed through operator entered values to slightly open the outside air damper and the second point of the two-point calibration accuracy check of sensing element-to-DDC system readout for outside air, return air, and space temperatures shall be performed. The space temperature setpoint shall be set as shown.

(4) An unoccupied mode signal shall be applied, and it shall be verified that the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The space temperature shall be artificially changed to below the night setback temperature setpoint, and it shall be verified that the HVAC system starts; the space temperature shall be set to above the night setback setpoint, and it shall be verified that the HVAC system stops. The night setback temperature setpoint shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential pressure switch input signal shall be simulated at the device. It shall be verified that the filter alarm is initiated. The differential pressure switch shall be set at the setpoint.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified. It shall be verified that a low temperature alarm is initiated. The freezestat shall be set at the setpoint. The HVAC system shall be restarted by manual restart and it shall be verified that the alarm returns to normal.

(7) With the HVAC system running, a smoke detector trip input signal at each detector shall be simulated, and control device actions and interlock functions as described in the Sequence of Operation shall be verified. Simulation shall be performed without false-alarms any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke

detector alarm is initiated. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the alarm returns to normal.

### 3.5 BALANCING, COMMISSIONING, AND TESTING

#### 3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The contractor shall tune the HVAC control system after all air system and hydronic system balancing has been completed, minimum damper positions set and a report has been issued.

#### 3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Communications requirements shall be as indicated. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

#### 3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the Commissioning Report and completion of balancing. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems.

#### 3.5.4 Endurance Test

The endurance test shall be used to demonstrate the specified overall system reliability requirement of the completed system. The endurance test shall not be started until the Government notifies the Contractor in writing that the performance verification test is satisfactorily completed.

The Government may terminate the testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test,

the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

a. Phase I (Testing). The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

b. Phase II (Assessment). After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the jobsite to present the results and recommendations to the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and test review meeting, the Government may require that the Phase I test be totally or partially rerun. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

#### 3.5.5 Posted and Panel Instructions

Posted and Panel Instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of laminated half-size drawings and shall include the control system schematic, equipment schedule, sequence of operation, wiring diagram, communication network diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a Routine Maintenance Checklist and as-built configuration check sheets. Panel instructions and one copy of the Operation and Maintenance Manuals, previously described herein, shall be placed inside each control panel or permanently affixed, by mechanical means, to a wall near the panel.

### 3.6 TRAINING

#### 3.6.1 Training Course Requirements

A training course shall be conducted for 6 operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. The training period, for a total of 32 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and 6 sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

#### 3.6.2 Training Course Content

For guidance in planning the required instruction, the Contractor shall

assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

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## SECTION 15990A

## TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

06/03

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002) National Standards for Total System Balance

## NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB TABES (1998) Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

## SHEET METAL &amp; AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVACTAB (2002) HVAC Systems - Testing, Adjusting and Balancing

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G, AE

Three copies of the TAB Schematic Drawings and Report Forms, no later than 21 days prior to the start of TAB field measurements.

## SD-03 Product Data

TAB Related HVAC Submittals; G, AE

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB Specialist.

TAB Procedures; G, AE

Proposed procedures for TAB, submitted with the TAB Schematic



Drawings and Report Forms.

Calibration; G, RE

List of each instrument to be used during TAB, stating calibration requirements required or recommended by both the TAB Standard and the instrument manufacturer and the actual calibration history of the instrument, submitted with the TAB Procedures. The calibration history shall include dates calibrated, the qualifications of the calibration laboratory, and the calibration procedures used.

Systems Readiness Check; G, RE

Proposed date and time to begin the Systems Readiness Check, no later than 7 days prior to the start of the Systems Readiness Check.

TAB Execution; G, RE

Proposed date and time to begin field measurements, making adjustments, etc., for the TAB Report, submitted with the Systems Readiness Check Report.

TAB Verification; G, RE

Proposed date and time to begin the TAB Verification, submitted with the TAB Report.

#### SD-06 Test Reports

Design Review Report; G, AE

A copy of the Design Review Report, no later than 14 days after approval of the TAB Firm and the TAB Specialist.

Systems Readiness Check; G, RE

A copy of completed checklists for each system, each signed by the TAB Specialist, at least 7 days prior to the start of TAB Execution. All items in the Systems Readiness Check Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Report; G, AE

Three copies of the completed TAB Reports, no later than 7 days after the execution of TAB. All items in the TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Verification Report; G, AE

Three copies of the completed TAB Verification Report, no later than 7 days after the execution of TAB Verification. All items in the TAB Verification Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National

Association used as the TAB Standard.

#### SD-07 Certificates

Ductwork Leak Testing, G, RE

A written statement signed by the TAB Specialist certifying that the TAB Specialist witnessed the Ductwork Leak Testing, it was successfully completed, and that there are no known deficiencies related to the ductwork installation that will prevent TAB from producing satisfactory results.

TAB Firm; G, RE

Certification of the proposed TAB Firm's qualifications by either AABC, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Firm or disciplinary action taken by AABC, NEBB or TABB against the proposed TAB Firm shall be described in detail.

TAB Specialist; G, RE

Certification of the proposed TAB Specialist's qualifications by either AABC, NEBB, or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Specialist or disciplinary action taken by AABC, NEBB, or TABB against the proposed TAB Specialist shall be described in detail.

#### 1.3 SIMILAR TERMS

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

##### SIMILAR TERMS

Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.	SMACNA's Procedures
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems	Construction Phase	Field Readiness	Field

## SIMILAR TERMS

Readiness Check	Inspection	Check & Preliminary Field Procedures.	Readiness Check & Prelim. Field Procedures
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## 1.4 TAB STANDARD

TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB TABES, or SMACNA HVACTAB unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc., shall, as nearly as practical, be used to satisfy the Contract requirements. The TAB Standard shall be used for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures shall be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

## 1.5 QUALIFICATIONS

## 1.5.1 TAB Firm

The TAB Firm shall be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems and building systems commissioning. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm shall be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm shall be a subcontractor of the prime Contractor and shall be financially and corporately independent of the mechanical subcontractor, and shall report to and be paid by the prime Contractor.

## 1.5.2 TAB Specialist

The TAB Specialist shall be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification shall be maintained for the entire duration of

duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

#### 1.6 TAB SPECIALIST RESPONSIBILITIES

All TAB work specified herein and in related sections shall be performed under the direct guidance of the TAB Specialist. The TAB Specialist shall participate in the commissioning process specified in Section 15995A COMMISSIONING OF HVAC SYSTEMS.

### PART 2 PRODUCTS (Not Applicable)

### PART 3 EXECUTION

#### 3.1 DESIGN REVIEW

The TAB Specialist shall review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

#### 3.2 TAB RELATED HVAC SUBMITTALS

The TAB Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the TAB Specialist when submitted to the Government. The TAB Specialist shall also ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

#### 3.3 TAB SCHEMATIC DRAWINGS AND REPORT FORMS

A schematic drawing showing each system component, including balancing devices, shall be provided for each system. Each drawing shall be accompanied by a copy of all report forms required by the TAB Standard used for that system. Where applicable, the acceptable range of operation or appropriate setting for each component shall be included on the forms or as an attachment to the forms. The schematic drawings shall identify all testing points and cross reference these points to the report forms and procedures.

#### 3.4 DUCTWORK LEAK TESTING

The TAB Specialist shall witness the Ductwork Leak Testing specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and approve the results as specified in Paragraph TAB RELATED HVAC SUBMITTALS.

### 3.5 TESTING, ADJUSTING, AND BALANCING

#### 3.5.1 TAB Procedures

Step by step procedures for each measurement required during TAB Execution shall be provided. The procedures shall be oriented such that there is a separate section for each system. The procedures shall include measures to ensure that each system performs as specified in all operating modes, interactions with other components (such as exhaust fans, relief vents, etc.) and systems, and with all seasonal operating differences, diversity, simulated loads, and pressure relationships required.

#### 3.5.2 Systems Readiness Check

The TAB Specialist shall inspect each system to ensure that it is complete, including installation and operation of controls, and that all aspects of the facility that have any bearing on the HVAC systems, including installation of ceilings, walls, windows, doors, and partitions, are complete to the extent that TAB results will not be affected by any detail or touch-up work remaining. The TAB Specialist shall also verify that all items such as ductwork and piping ports, terminals, connections, etc., necessary to perform TAB shall be complete during the Systems Readiness Check.

#### 3.5.3 Preparation of TAB Report

Preparation of the TAB Report shall begin only when the Systems Readiness Report has been approved. The Report shall be oriented so that there is a separate section for each system. The Report shall include a copy of the appropriate approved Schematic Drawings and TAB Related Submittals, such as pump curves, fan curves, etc., along with the completed report forms for each system. The operating points measured during successful TAB Execution and the theoretical operating points listed in the approved submittals shall be marked on the performance curves and tables. Where possible, adjustments shall be made using an "industry standard" technique which would result in the greatest energy savings, such as adjusting the speed of a fan instead of throttling the flow. Any deficiencies outside of the realm of normal adjustments and balancing during TAB Execution shall be noted along with a description of corrective action performed to bring the measurement into the specified range. If, for any reason, the TAB Specialist determines during TAB Execution that any Contract requirement cannot be met, the TAB Specialist shall immediately provide a written description of the deficiency and the corresponding proposed corrective action necessary for proper system operation to the Contracting Officer.

#### 3.5.4 TAB Verification

The TAB Specialist shall recheck ten percent of the measurements listed in the Tab Report and prepare a TAB Verification Report. The measurements selected for verification and the individuals that witness the verification will be selected by the Contracting Officer's Representative (COR). The measurements will be recorded in the same manner as required for the TAB Report. All measurements that fall outside the acceptable operating range specified shall be accompanied by an explanation as to why the measurement does not correlate with that listed in the TAB Report and a description of corrective action performed to bring the measurement into the specified range. The TAB Specialist shall update the original TAB report to reflect any changes or differences noted in the TAB verification report and submit the updated TAB report. If over 20 percent of the measurements selected by

the COR for verification fall outside of the acceptable operating range specified, the COR will select an additional ten percent for verification.

If over 20 percent of the total tested (including both test groups) fall outside of the acceptable range, the TAB Report shall be considered invalid and all contract TAB work shall be repeated beginning with the Systems Readiness Check.

#### 3.5.5 Marking of Setting

Following approval of TAB Verification Report, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

#### 3.5.6 Identification of Test Ports

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

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## SECTION 15995A

## COMMISSIONING OF HVAC SYSTEMS

07/03

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Commissioning Team; G, RE

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

Tests; G, RE

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

Pre-Commissioning Checks; G, RE

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

## SD-06 Test Reports

Test Reports; G, RE

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

## 1.2 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 15951A DIRECT DIGITAL CONTROLS FOR HVAC and Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Seismic details shall be in accordance with



Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Appendices A and B are provided as a general checklist and have been prepared to best match the various equipment selected during the design of this project. Each checklist shown in Appendices A and B shall be reviewed and modified as necessary to reflect equipment actually installed during construction of the project. The commissioning team shall review the accuracy and applicability of each item in the checklist and revise as needed. Equipment shown in the checklist but not installed for the project shall be annotated as "NA". Likewise, equipment installed but not listed in the checklist shall be added or revised accordingly. A note as to why it was added or revised shall be inserted with the reviewer's initial. The commissioning team shall also add or modify to any of the equipment checklist items as required and/or specified by the equipment manufacturer.

Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date, unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if

any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members. The Contractor shall submit Test Reports as specified in the Submittals paragraph.

#### 3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks shall be corrected and retested in accordance with the applicable contract requirements.

#### 3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

## APPENDIX A

## PRE-COMMISSIONING CHECKLISTS

## Pre-commissioning checklist - Piping

For Chilled Water and Hot (Heating) Water Piping Systems

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

## Pre-commissioning Checklist - Ductwork

For Air Handler: AHU's COF 1 Through 8  
 AHU's HQ 1 Through 3

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___
NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.								
d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
g. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
h. Verify smoke and fire damper operation.	___	___	X	___	___	___	___	___
i. Flexible connectors installed as specified	___	___	X	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU's COF 5 Through 8  
 AHU's HQ 1 Through 3

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed. (Visually verify drainage by pouring a cup of water into drain pan.)	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Coils								
a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___
b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___
c. Hot water piping properly connected.	___	___	X	X	X	___	___	___
d. Hot water piping pressure tested.	___	___	X	X	X	___	___	___
e. Air vents installed on water coils as specified.	___	___	X	X	X	___	___	___
f. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___

## Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU's COF 5 Through 8  
 AHU's HQ 1 Through 3

Checklist Item	Q	M	E	T	C	D	O	U
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location, installation and calibration of duct static pressure sensor.	___	___	X	___	___	___	___	___
f. Fan air volume controller operable.	___	___	X	___	___	___	___	___
g. Air handler controls system operational.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.	___	___	X	___	___	___	___	___
b. TAB report submitted.	___	___	X	___	X	___	___	___
c. TAB results within limits specified in Section 15990A								
d. TAB results for outside air intake within limits specified in Section 15990A	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: COF 5/A - 5D, COF 6/A - 6D, COF 7A - 7D, COF 8A - 8D  
 HQ 1/A - 1U, HQ 2/A - 2L, HQ 3/A - 3H

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. VAV terminal in place.	___	___	X	X	X	___	___	___
b. VAV terminal ducted.	___	___	X	X	X	___	___	___
c. VAV terminal connected to controls.	___	___	X	X	___	___	___	___
d. Reheat coil connected to hot water pipe.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Controls								
a. Cooling only VAV terminal controls set.	___	___	X	X	___	___	___	___
b. Cooling only VAV controls verified.	___	___	X	X	___	___	___	___
c. Reheat VAV terminal controls set.	___	___	X	X	___	___	___	___
d. Reheat terminal/coil controls verified.	___	___	X	X	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Verify terminal maximum air flow set.	___	___	X	___	___	___	___	___
b. Verify terminal minimum air flow set.	___	___	X	___	___	___	___	___
c. TAB operation complete.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: ACCU COF-1, ACCU COF-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation	___	___	X	X	X	___	___	___
b. Refrigerant pipe leak tested.	___	___	X	X	X	___	___	___
c. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions.	___	___	X	X	X	___	___	___
d. Check condenser fans for proper rotation.	___	___	X	___	X	___	___	___
e. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___	___	___
Controls								
a. Unit safety/protection devices tested.	___	___	X	X	___	___	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___	___	___



## Pre-commissioning Checklist - Pumps

For Pump: HWP COF-1, CWP COF-1  
HWP HQ-1, CWP HQ-1, CWP HQ-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Pumps grouted in place.	___	___	X	X	X	___	___	___
b. Pump vibration isolation devices functional.	___	___	X	X	X	___	___	___
c. Pump/motor coupling alignment verified.	___	___	X	X	X	___	___	___
d. Piping system installed.	___	___	X	X	X	___	___	___
e. Piping system pressure tested.	___	___	X	X	X	___	___	___
f. Pump not leaking.	___	___	X	X	X	___	___	___
g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to pump disconnect.	___	___	___	X	X	___	___	___
b. Pump rotation verified.	___	___	___	X	X	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Pressure/temperature gauges installed.	___	___	X	___	X	___	___	___
b. Piping system cleaned.	___	___	X	X	X	___	___	___
c. Chemical water treatment complete.	___	___	X	X	X	___	___	___
d. Water balance complete.	___	___	X	___	X	___	___	___
e. Water balance with design maximum flow.	___	___	X	___	X	___	___	___
f. TAB Report submitted.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: WCU COF-1, WCU HQ-1, WCU HQ-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Chiller properly piped.	___	___	X	___	___	___	___	___
b. Chilled water pipe leak tested.	___	___	X	X	X	___	___	___
c. Verify that refrigerant used complies with specified requirements.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Separate power is supplied to electric heating tape.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Factory startup and checkout complete.	___	___	X	X	___	___	___	___
b. Chiller safety/protection devices tested.	___	___	X	X	___	___	___	___
c. Chilled water flow switch installed.	___	___	X	X	___	___	___	___
d. Chilled water flow switch tested.	___	___	X	X	___	___	___	___
e. Chilled water pump interlock installed.	___	___	X	X	X	___	___	___
f. Chilled water pump interlock tested.	___	___	___	X	___	___	___	___

## Pre-commissioning Checklist - Hot Water Boiler

For Boiler: B COF-1, B HQ-1

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Boiler flue installed.	___	___	X	___	___	___	___	___
b. Boiler hot water piping installed.	___	___	X	___	___	___	___	___
c. Boiler hot water piping tested.	___	___	X	X	___	___	___	___
d. Boiler makeup water piping installed.	___	___	X	___	___	___	___	___
e. Boiler gas piping installed.	___	___	X	X	X	___	___	___
f. Boiler gas piping tested.	___	___	X	X	X	___	___	___
g. Manufacturer's required maintenance clearance provided.	___	___	X	___	___	___	___	___
Startup								
a. Boiler system cleaned and filled with treated water.	___	___	X	___	___	___	___	___
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___	___	___
c. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___	___	___
d. Boiler water treatment system functional.	___	___	X	X	___	___	___	___
e. Boiler startup and checkout complete.	___	___	X	X	___	___	___	___
f. Combustion efficiency demonstrated.	___	___	X	___	X	___	___	___
Electrical								
a. Verify that power disconnect is located within sight of the unit served.	___	___	___	X	___	___	___	___
Controls								
a. Hot water pump interlock installed.	___	___	___	X	___	___	___	___
b. Hot water pump interlock tested.	___	___	___	X	___	___	___	___
c. Hot water heating system balanced.	___	___	X	X	___	___	___	___
d. Hot water heating controls operational.	___	___	X	X	___	___	___	___

## Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: FCU-A

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Access doors/removable panels are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed.	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Coils								
a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___
b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Construction filters removed and replaced.	___	___	X	___	___	___	___	___
b. TAB results within limits specified in	___	___	___	___	___	___	___	___

## Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: FCU-A

Checklist Item  
Section 15990A

Q M E T C D O U

c. TAB Report submitted.

\_\_\_ \_\_\_ X \_\_\_ X \_\_\_ \_\_\_ \_\_\_

## Pre-commissioning Checklist - Unit Heater

For Unit Heater: UH COF-1, UH COF-2  
UH HQ-1, UH HQ-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Hot water piping properly connected.	___	___	X	___	___	___	___	___
b. Hot water piping pressure tested.	___	___	X	___	___	___	___	___
c. Air vent installed on hot water coil with shutoff valve as specified.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___	___	___
Controls								
a. Control valves properly installed.	___	___	X	___	___	___	___	___
b. Control valves operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB Report submitted.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - Supply and Exhaust Fans

For Exhaust Fan: EFCOF 1-1, EFCOF 1-2, EFCOF 2-1, EFCOF 3-2, EFCOF 4-1, EFCOF 5-1, EFCOF 6-1, EFCOF 7-1, EFCOF 8-1, SFCOF-1, SFCOF-2  
 EFHQ 1-1, EFHQ 1-2, EFHQ 2-1, EFHQ 3-1, SFHQ-1, EFHQ-4,  
 EFHQ - OV, EFHQ-BS

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results within limits specified in Section 15990A	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - HVAC System Controls

For HVAC System: DDC System

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Layout of control panel matches drawings.	___	___	X	X	___	___	___	___
c. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
d. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___	___	___
e. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
f. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___	___	___
g. Control wiring labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
h. Shielded wiring used on electronic sensors.	___	___	X	X	___	___	___	___
Main Power								
a. 110 volt AC power available to panel.	___	___	___	X	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___



## Pre-commissioning Checklist - Single System Fan Coil Units

For Fan Coil Unit: A/C COF-1, A/C COF-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	__	__	X	X	X	__	__	__
b. Inspection and access doors are operable and sealed.	__	__	X	__	X	__	__	__
c. Casing undamaged.	__	__	X	X	X	__	__	__
d. Insulation undamaged.	__	__	X	X	X	__	__	__
e. Condensate drainage is unobstructed.	__	__	X	X	X	__	__	__
f. Any damage to coil fins has been repaired.	__	__	X	__	X	__	__	__
g. Manufacturer's required maintenance clearance provided.	__	__	X	X	X	__	__	__

## Electrical

a. Power available to unit disconnect.	__	__	__	X	X	__	__	__
b. Power available to unit control.	__	__	__	X	__	__	__	__
c. Proper motor rotation verified.	__	__	__	__	X	__	__	__
d. Verify that power disconnect is located within sight of the unit it controls.	__	__	__	X	__	__	__	__

## Coils

a. Refrigerant piping properly connected.	__	__	X	X	X	__	__	__
b. Refrigerant piping pressure tested.	__	__	X	X	X	__	__	__
c. Any damage to coil fins has been repaired.	__	__	X	__	X	__	__	__

## Controls

a. Control valves/actuators properly installed.	__	__	X	__	__	__	__	__
b. Control valves/actuators operable.	__	__	X	__	__	__	__	__
c. Verify proper location and installation of thermostat.	__	__	X	__	__	__	__	__

## Testing, Adjusting, and Balancing (TAB)

a. Construction filters removed and replaced.	__	__	X	__	X	__	__	__
b. TAB results within limits specified in								

## Pre-commissioning Checklist - Single System Fan Coil Units

For Fan Coil Unit: A/C COF-1, A/C COF-2

Checklist Item

Section 15990A

			Q	M	E	T	C	D	O	U
	___	___	X	___	X	___	___	___		
c. TAB Report submitted.					X	___	X	___	___	___

APPENDIX B  
FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

## Functional Performance Test Checklist - Pumps

For Pump: Provide for Each Pump

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON \_\_\_\_\_ AUTO \_\_\_\_\_ OFF \_\_\_\_\_

a. Verify pressure drop across strainer:

Strainer inlet pressure \_\_\_\_\_ psig  
Strainer outlet pressure \_\_\_\_\_ psig

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

	DESIGN	SYSTEM TEST	ACTUAL
Pump inlet pressure (psig)	_____	_____	_____
Pump outlet pressure (psig)	_____	_____	_____

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (gpm)	_____	_____

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (gpm)	_____	_____

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

b. Minimum flow:

## Functional Performance Test Checklist - Pumps

For Pump: Provide for Each Pump

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

3. Unusual vibration, noise, etc.

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Contracting Officer's Representative

Using Agency's Representative

## Functional Performance Test Checklist - VAV Terminals

The Contracting officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow \_\_\_\_\_ cfm  
Minimum flow \_\_\_\_\_ cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting \_\_\_\_\_ cfm  
Minimum flow setting \_\_\_\_\_ cfm

b. Cooling with reheat VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow \_\_\_\_\_ cfm  
Minimum flow \_\_\_\_\_ cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting \_\_\_\_\_ cfm  
Minimum flow setting \_\_\_\_\_ cfm

Reheat coil operation range (full open to full closed) \_\_\_\_\_

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via set point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point. \_\_\_\_\_ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation. \_\_\_\_\_

(2) Check primary air damper maximum/minimum flow settings.

Maximum flow setting \_\_\_\_\_ cfm  
Minimum flow setting \_\_\_\_\_ cfm

(3) Check blower fan flow. \_\_\_\_\_ cfm

## Functional Performance Test Checklist - VAV Terminals

(4) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register).

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(5) Verify that no recirculated air is being induced when box is in full cooling.

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2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing Representative

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Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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## Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU COF-5, COF-6, COF-7, COF-8  
AHU HQ-1, HQ-2, HQ-3

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply fan operating mode is initiated:

(1) All dampers in normal position and fan inlet vanes modulate to maintain the required static pressure. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

(4) VAV fan controller shall "soft-start" fan. \_\_\_\_\_

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the design static pressure Class shown.

---

b. Occupied mode of operation.

(1) Outside air damper open. \_\_\_\_\_

(2) Chilled water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(3) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.

---

c. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the supply fan off mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling.



## Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU COF-5, COF-6, COF-7, COF-8  
AHU HQ-1, HQ-2, HQ-3

	Max cooling	Min cooling
Supply air volume _____ cfm)	_____	_____
Supply air temp. (_____ degrees F)	_____	_____

- g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_
- h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

## Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: WCU-COF-1, WCU-HQ-1, WCU-HQ-2

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes chiller start sequence. \_\_\_\_\_

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_

d. Verify functioning of "soft start" sequence. \_\_\_\_\_

e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. \_\_\_\_\_

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

	DESIGN	SYSTEM TEST	ACTUAL
Chiller inlet pressure (psig)	_____	_____	_____
Chiller outlet pressure (psig)	_____	_____	_____

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

4. Record the following information:

Ambient dry bulb temperature \_\_\_\_\_ degrees F  
 Ambient wet bulb temperature \_\_\_\_\_ degrees F  
 Entering chilled water temperature \_\_\_\_\_ degrees F  
 Leaving chilled water temperature \_\_\_\_\_ degrees F

5. Unusual vibration, noise, etc.

\_\_\_\_\_  
 \_\_\_\_\_

## Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: WCU-COF-1, WCU-HQ-1, WCU-HQ-2

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing Representative

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Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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## Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: ACCU-COF-1, ACCU-COF-2

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start air handling unit. Verify control system energizes condensing unit start sequence. \_\_\_\_\_

b. Shut off air handling equipment to verify condensing unit de-energizes. \_\_\_\_\_

c. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. \_\_\_\_\_

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

3. Record the following information:

Ambient dry bulb temperature	_____	degrees F
Ambient wet bulb temperature	_____	degrees F
Suction pressure	_____	psig
Discharge pressure	_____	psig

4. Unusual vibration, noise, etc.

\_\_\_\_\_  
\_\_\_\_\_

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing

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Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: ACCU-COF-1, ACCU-COF-2

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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## Functional Performance Test Checklist - Hot Water Boiler

For Boiler: B COF-1, B HQ-1

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes boiler start sequence. \_\_\_\_\_

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. \_\_\_\_\_

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

	DESIGN	SYSTEM TEST	ACTUAL
Boiler inlet pressure (psig)	_____	_____	_____
Boiler outlet pressure (psig)	_____	_____	_____
Boiler flow rate (gpm)	_____	_____	_____
Flue-gas temperature at boiler outlet		_____	_____
Percent carbon dioxide in flue-gas		_____	_____
Draft at boiler flue-gas exit		_____	_____
Draft or pressure in furnace		_____	_____
Stack emission pollutants concentration	_____	_____	_____
Fuel type	_____	_____	_____
Combustion efficiency	_____	_____	_____

3. Record the following information:

Ambient temperature	_____	degrees F
Entering hot water temperature	_____	degrees F
Leaving hot water temperature	_____	degrees F

4. Verify temperatures in item 3 are in accordance with the reset schedule. \_\_\_\_\_

5. Verify proper operation of boiler safeties. \_\_\_\_\_

6. Unusual vibration, noise, etc. \_\_\_\_\_

## Functional Performance Test Checklist - Hot Water Boiler

For Boiler: B COF-1, B HQ-1

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7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement.

---

8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Contracting Officer's Representative

Using Agency's Representative

## Functional Performance Test Checklist - Fan Coil Units

The Contracting Officer will select fan coil units to be spot-checked during the functional performance test. The number of terminals shall not exceed 2 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

a. Cooling only fan coils:

- (1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to cooling set point minus 10 degrees and return to cooling set point. \_\_\_\_\_
- (2) Check blower fan air flow. \_\_\_\_\_ cfm
- (3) Check cooling coil water flow. \_\_\_\_\_ gpm
- (4) Verify proper operation of cooling water control valve. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Contracting Officer's Representative

Using Agency's Representative



## Functional Performance Test Checklist - Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 2 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. \_\_\_\_\_

b. Check blower fan speed. \_\_\_\_\_rpm

c. Check heating mode inlet air temperature. Check heating mode inlet air temperature. \_\_\_\_\_ degrees F

d. Check heating mode outlet air temperature. Check heating mode outlet air temperature. \_\_\_\_\_ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

## Functional Performance Test Checklist - HVAC Controls

For HVAC System: DDC System

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 2 percent.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor \_\_\_\_\_  
Manual measurement \_\_\_\_\_  
Panel reading value \_\_\_\_\_

c. Verify system stability by changing the controller set point as follows:

- (1) Air temperature - 10 degrees F
- (2) Water temperature - 10 degrees F
- (3) Static pressure - 10 percent of set point
- (4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

e. Verify interlock with fire alarm control panel.

f. Verify interlock with EMCS.

g. Change controller set point 10 percent with EMCS and verify correct response.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Functional Performance Test Checklist - HVAC Controls

For HVAC System: DDC System

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contractor's Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

-- End of Section --

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DIVISION 16 - ELECTRICAL

SECTION 16070A

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

04/99

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-- End of Section Table of Contents --

## SECTION 16070A

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT  
04/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04 (1998) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 1570 (1995; Rev thru Nov 1999) Fluorescent  
Lighting Fixtures

UL 1571 (1995; Rev thru Nov 1999) Incandescent  
Lighting Fixtures

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Lighting Fixtures and Ceiling Fans in Buildings  
Equipment Requirements

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

## SD-03 Product Data

Lighting Fixtures and Ceiling Fans in Buildings  
Equipment Requirements

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing

Copies of the Design Calculations with the Drawings. Calculations shall be approved, certified, stamped and signed by a Registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the electrical equipment and systems listed below. Structural requirements shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

#### 1.3.2 Electrical Equipment

Electrical equipment requirements shall include the following items to the extent required on the drawings or in other sections of these specifications:

- Panels
- Light Fixtures
- Transformers

#### 1.3.3 Electrical Systems

The following electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

- Panels
- Light Fixtures
- Transformers

#### 1.3.4 Contractor Designed Bracing

The Contractor shall design the bracing in accordance with TI 809-04 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. TI 809-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using TI 809-04 are based on strength design; therefore, the AISC LRFP specifications shall be used for the design. The bracing for the following electrical equipment and systems shall be developed by the Contractor:

- Transformers
- Light Fixtures
- Panels

#### 1.3.5 Conduits Requiring No Special Seismic Restraints

Seismic restraints may be omitted from electrical conduit less than 2-1/2 inches trade size. All other interior conduit, shall be seismically protected.

## PART 2 PRODUCTS

### 2.1 LIGHTING FIXTURE SUPPORTS

Lighting fixtures and supports shall conform to UL 1570 or UL 1571 as applicable.

### 2.2 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

## PART 3 EXECUTION

### 3.1 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe in accordance with Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

### 3.2 LIGHTING FIXTURES AND CEILING FANS IN BUILDINGS

Lighting fixtures and ceiling fans and supports shall conform to the following:

#### 3.2.1 Pendant Fixtures

Pendant fixtures shall conform to the requirements of TI 809-04, Chapter 10.

#### 3.2.2 Ceiling Attached Fixtures

##### 3.2.2.1 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system built in accordance with Section 09510 ACOUSTICAL CEILINGS. Seismic protection for the fixtures shall conform to the requirements of TI 809-04, Chapter 10. Recessed lighting fixtures not over 56 pounds in weight may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

##### 3.2.2.2 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system built in accordance with Section 09510 ACOUSTICAL CEILINGS. Seismic protection for the fixtures shall conform to the requirements of TI 809-04, Chapter 10.

#### 3.2.3 Assembly Mounted on Outlet Box

A supporting assembly, that is intended to be mounted on an outlet box, shall be designed to accommodate mounting features on 4 inch boxes, plaster rings, and fixture studs.

#### 3.2.4 Lateral Force

Structural requirements for light fixture bracing shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

-- End of Section --



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## SECTION 16264A

## DIESEL-GENERATOR SET, STATIONARY 15-300 KW, STANDBY APPLICATIONS

06/02

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-- End of Section Table of Contents --

## SECTION 16264A

DIESEL-GENERATOR SET, STATIONARY 15-300 KW, STANDBY APPLICATIONS  
**06/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.11 (1987; R 2002) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 975 (2004a) Diesel Fuel Oils

## ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P (1995a) Engine Driven Generator Sets

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE Std 1 (2000) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation

IEEE Std 100 (2001) IEEE Standard Dictionary of Electrical and Electronics Terms

IEEE Std 120 (1989) Electrical Measurements in Power Circuits

IEEE Std 519 (1992) Harmonic Control in Electrical Power Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (2002) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

NEMA MG 1 (2003) Motors and Generators

NEMA SG 6	(2000) Power Switching Equipment
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 30	(2003) Flammable and Combustible Liquids Code
NFPA 37	(2002) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2002) National Electrical Code
NFPA 99	(2002) Health Care Facilities
NFPA 110	(2002) Emergency and Standby Power Systems
SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)	
SAE ARP 892	(1965; R 1994) D-C Starter-Generator, Engine
SAE J 537	(1996) Storage Batteries
UNDERWRITERS LABORATORIES (UL)	
UL 489	(2002) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 1236	(2002) Battery Chargers for Charging Engine-Starter Batteries

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Drawings; G, RE

- a. Base-mounted equipment, complete with base and attachments including anchor bolt template and recommended clearances for maintenance and operation.
- b. Starting system.
- c. Fuel system.
- d. Cooling system.
- e. Exhaust system.
- f. Electric wiring of relays, breakers, programmable controllers, and switches including single line and wiring diagrams.

- g. Lubrication system, including piping, pumps, strainers, filters, electric heater, controls and wiring.
- h. Location, type, and description of vibration isolation devices.
- i. The safety system, including wiring schematics.
- j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and all instrumentation.
- k. Engine-generator set rigging points and lifting instructions.

#### Acceptance

Drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Layout drawings shall be revised to reflect the as-built conditions and submitted with the as-built drawings.

#### SD-03 Product Data

##### Performance Tests; G, RE

Calculations of the engine and generator output power capability, including efficiency and parasitic load data.

##### Sound Limitations; G, RE

Sound power level data for the packaged unit operating at 100% load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification.

##### Generator; G, RE

Generator KW rating and short circuit capacity (both symmetric and asymmetric).

##### Integral Main Fuel Storage Tank; G, RE

##### Cooling System; G, RE

a. The maximum and minimum allowable inlet temperatures of the coolant fluid.

b. The maximum allowable temperature rise in the coolant fluid through the engine.

##### Manufacturer's Catalog; G, RE

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate specification compliance.

#### Instructions

Instructions including: the manufacturer's pre-start checklist

and precautions; startup procedures for test mode, manual-start mode, and automatic-start mode, (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Instructions shall be weatherproof, laminated in plastic, framed, and posted where directed. Posted data shall include wiring and control diagrams showing the key mechanical and electrical control elements, and a diagrammatic layout of the system.

#### Experience

Statement showing that each component manufacturer has a minimum of 7 years experience in the manufacture, assembly and sale of components used with stationary diesel-engine generator sets for commercial use.

Statement showing that the engine-generator set manufacturer/assembler has a minimum of 7 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

#### Field Engineer

A letter listing the qualifications, schools, formal training, and experience of the field engineer.

#### General Installation

A complete copy of the manufacturer's installation procedures. A detailed description of the manufacturer's recommended break-in procedure.

### SD-06 Test Reports

#### Onsite Inspection and Tests

a. A letter giving notice of the proposed dates of all onsite inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the Contractor's proposed procedures for onsite tests including the test including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least 14 days prior to beginning tests.

c. Six copies of the onsite test data described below in 8-1/2 x 11 inch 3-ring binders with a separate section for each test. Sections shall be separated by dividers with tabs. Data plots shall be full size 8-1/2 x 11 inches minimum), showing all grid lines, with full resolution.

(1) A description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

- (4) The date of testing.
- (5) The parameters verified.
- (6) The condition specified for the parameter.
- (7) The test results, signed and dated.
- (8) A description of all adjustments made.

#### SD-07 Certificates

##### Prototype Tests

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

##### Reliability and Durability

Documentation which cites engines and generators in similar service to demonstrate compliance with the requirements of this specification. Certification does not exclude annual technological improvements made by a manufacturer in the basic standard model set on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets all the performance requirements of this specification. For each different set, 2 like sets shall have performed satisfactorily in a stationary power application, independent and separate from the physical location of the manufacturer's and assembler's facilities, for a minimum of 2 consecutive years without any failure to start, including periodic exercise. The certification shall state that for the set proposed to meet this specification, there were no failures resulting in downtime for repairs in excess of 72 hours or any failure due to overheating during 2 consecutive years of service. Like sets are of the same model, speed, bore, stroke, number and configuration of cylinders, and output power rating. Like generators are of the same model, speed, pitch, cooling, exciter, voltage regulator and output power rating. A list shall be provided with the name of the installations, completion dates, and name and telephone number of a point of contact.

##### Emissions

A certification from the engine manufacturer stating that the engine exhaust emissions meet federal, state, and local regulations and restrictions specified. At a minimum, this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HAPs).

##### Sound limitations

A certification from the manufacturer stating that the sound emissions meet the specification.

##### Materials and Equipment



A letter stating that where materials or equipment are specified to comply with requirements of UL, or other standards, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

#### Factory Inspection and Tests

A certification that each engine generator set passed the factory tests and inspections and a list of the test and inspections.

#### Inspections

A letter certifying that all facilities are complete and functional, that each system is fully functional, and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

#### Cooling System

Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

### 1.3 SYSTEM DESCRIPTION

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine generator set shall satisfy the requirements specified in the Engine Generator Parameter Schedule.

#### 1.3.1 Engine-Generator Parameter Schedule

##### ENGINE GENERATOR PARAMETER SCHEDULE

Service Load	230 kW
Power Factor	0.8 lagging
Motor Starting kVA (maximum)	65 kVA
Maximum Speed	1800 rpm
Engine-Generator Application	stand-alone
Engine Cooling Type	water/ethylene glycol
Heat Exchanger Type	fin-tube
Governor Type	Isochronous
Frequency Bandwidth steady state	$\pm 0.25\%$

Voltage Regulation (No load to full load)	$\pm 2\%$ (max.)
Voltage Bandwidth (steady state)	$\pm 2\%$
Frequency	60 Hz
Voltage	480 volts
Phases	3 Phase, Wye
Minimum Generator Subtransient Reactance	0.092 percent
Nonlinear Loads	40 - 50 kVA
Max Step Load Increase	55% of Service Load at 88% PF
Max Step Load Decrease (without shutdown)	100% of Service Load at 88% PF
Max Time to Start and be Ready to Assume Load	10 seconds
Max Summer Outdoor Temp (Ambient)	105 degrees
Min Winter Outdoor Temp (Ambient)	-5 degrees
Installation Elevation	50 above sea level

#### 1.3.2 Output Capacity

Each generator set shall provide power equal to the sum of service load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

#### 1.3.3 Power Rating

Standby ratings shall be in accordance with EGSA 101P.

### 1.4 GENERAL REQUIREMENTS

#### 1.4.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter, mounted, assembled, and aligned on one base; and all other necessary ancillary equipment. Sets shall be assembled and attached to the base prior to shipping. Set components shall be environmentally suitable for the locations shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. A generator strip heater shall be provided for moisture control when the generator is not operating.

#### 1.4.2 Nameplates

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number, and rating number on a plate secured to the equipment. As a minimum, nameplates shall be provided for: Engines; Generators; Regulators; Pumps and pump motors; Governors; Generator Breaker.

Where the following equipment is provided as a standard component by the diesel-engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Exhaust mufflers	Exciters
Silencers	
Battery	

#### 1.4.3 Personnel Safety Device

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel during normal operation shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

#### 1.4.4 Verification of Dimensions

Before performing work, the premises shall be visited and details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies before performing any work.

#### 1.4.5 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, the design, fabrication and installation shall conform to the code.

#### 1.4.6 Engine Generator Set Enclosure

The engine generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at rated load under secured conditions. Doors shall be provided for access to all controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than exhaust system. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

#### 1.4.7 Vibration Isolation

The maximum engine-generator set vibration in the horizontal, vertical and axial directions shall be limited to 6 mils (peak-peak RMS), with an overall velocity limit of RMS, for all speeds through 110% of rated speed. The engine-generator set shall be provided with vibration-isolation in accordance with the manufacturer's standard recommendation.

#### 1.4.8 Experience

Each component manufacturer shall have a minimum of 5 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacture/assembler shall have a minimum of 5 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

#### 1.4.9 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine-generator manufacturer's training courses on installation and operation and maintenance for engine generator sets.

### 1.5 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment in accordance with the manufacturers recommended storage procedures, before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

### 1.6 OPERATION AND MAINTENANCE MANUALS

The operation and maintenance manuals shall be submitted and approved prior to commencing onsite tests.

#### 1.6.1 Operation Manual

Three copies of the operation manual in 8-1/2 x 11 inch three-ring binders shall be provided. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8-1/2 x 11 inch plastic pockets with reinforced holes. The manual shall include:

- a. Step-by-step procedures for system startup, operation, and shutdown;
- b. Drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems with their controls, alarms, and safety systems;
- c. Procedures for interface and interaction with related systems to include automatic transfer switches uninterruptible power supplies.

#### 1.6.2 Maintenance Manual

Three copies of the maintenance manual containing the information described below in 8-1/2 x 11 inch three-ring binders shall be provided. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

- a. Procedures for each routine maintenance item. Procedures for

troubleshooting. Factory-service, take-down overhaul, and repair service manuals, with parts lists.

- b. The manufacturer's recommended maintenance schedule.
- c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components listed in paragraph GENERAL REQUIREMENTS.
- d. A list of spare parts for each piece of equipment and a complete list of materials and supplies needed for operation.

#### 1.7 SPECIAL TOOLS AND FILTERS

Two sets of special tools and two sets of filters required for maintenance shall be provided. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings. Two complete sets of filters shall be supplied in a suitable storage box. These filters shall be in addition to filters replaced after testing.

#### 1.8 DRAWINGS

Provide complete manufacturers generator drawings for gen-set supplied.

#### 1.9 PROTOTYPE TESTS

Provide manufacturers prototype tests of exact model of generator being supplied.

#### 1.10 RELIABILITY AND DURABILITY

Provide manufacturers documentation indicating reliability and durability of generator.

#### 1.11 EMISSIONS

Provide emissions documentation indicating compliance with federal, state and local restrictions.

#### 1.12 INSTRUCTIONS

Provide manufacturer's product instructions for materials used on project as described in SUBMITTALS paragraph in this section.

### PART 2 PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be as specified.

##### 2.1.1 Circuit Breakers, Low Voltage

NEMA AB 1, UL 489, and NEMA SG 6.

##### 2.1.2 Filter Elements (Fuel-oil, Lubricating-oil, and Combustion-air)

Manufacturer's standard.

### 2.1.3 Instrument Transformers

ANSI C12.11.

## 2.2 ENGINE

Each engine shall operate on No. 2-D diesel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, scavenged, supercharged or turbocharged. The engine shall be two- or four-stroke-cycle and compression-ignition type. The engine shall be vertical inline, V-, or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have no less than four cylinders. Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor.

## 2.3 FUEL SYSTEM

The fuel system for each engine generator set shall conform to the requirements of NFPA 30 and NFPA 37 and contain the following elements.

### 2.3.1 Pumps

#### 2.3.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

### 2.3.2 Filter

A minimum of one full flow fuel filter shall be provided for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

### 2.3.3 Relief/Bypass Valve

A relief/bypass valve shall be provided to regulate pressure in the fuel supply line, return excess fuel to a return line, and prevent the build-up of excessive pressure in the fuel system.

### 2.3.4 Integral Main Fuel Storage Tank

Each engine shall be provided with an integral main fuel tank. Each tank shall be factory installed and provided as an integral part of the diesel generator manufacturer's product. Each tank shall be provided with connections for fuel supply line, fuel return line, local fuel fill port, gauge, vent line, and float switch assembly. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the tank shall be below the flash point of the fuel. Each engine-generator set provided with weatherproof enclosures shall have its tank mounted within the enclosure. The fuel fill line shall be accessible without opening the enclosure.

#### 2.3.4.1 Capacity

Tank shall have capacity to supply fuel to the engine for an uninterrupted 72-hour period at 100% rated load without being refilled.

#### 2.3.4.2 Local Fuel Fill

Each local fuel fill port on the day tank shall be provided with a screw-on cap.

#### 2.3.4.3 Fuel Level Controls

- a. Each tank shall have a float-switch assembly to perform the following functions:
  - (1) Activate the "Low Fuel Level" alarm at 70% of the rated tank capacity.
  - (2) Activate the "Overfill Fuel Level" alarm at 95% of the rated tank capacity.

#### 2.3.4.4 Arrangement

Integral tanks may allow gravity flow into the engine. Gravity flow tanks and any tank that allows a fuel level above the fuel injectors shall be provided with an internal or external factory installed valve located as near as possible to the shell of the tank. The valve shall close when the engine is not operating.

### 2.4 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven oil pumps. Each system shall be furnished with a relief valve for oil pressure regulation (for closed systems) and a dip-stick for oil level indications. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

#### 2.4.1 Filter

One full-flow filter shall be provided for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

#### 2.4.2 Lube-Oil Sensors

Each engine shall be equipped with lube-oil pressure sensors. Pressure sensors shall be located downstream of the filters and provide signals for required indication and alarms.

## 2.5 COOLING SYSTEM

Each engine cooling system shall operate automatically while the engine is running. Each cooling system shall be sized for the maximum summer outdoor design temperature and site elevation. Water-cooled system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across the engine shall be no more than that recommended and submitted in accordance with paragraph SUBMITTALS.

### 2.5.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers.

### 2.5.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted in accordance with paragraph SUBMITTALS for the maximum summer outdoor design temperature and site elevation. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of application.

#### 2.5.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosive resistant film providing that corrosion measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via oversizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 7 psi. Each heat exchanger shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes. One tapped hole in the heat exchanger shall be equipped with a drain cock, the rest shall be plugged.

### 2.5.3 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

## 2.6 SOUND LIMITATIONS

The noise generated by the diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet at 45 degrees apart in all directions.

Frequency Band  
(Hz)

Maximum Acceptable  
Pressure Level  
(Decibels)



Frequency Band (Hz)	Maximum Acceptable Pressure Level (Decibels)
63	81
125	71
250	64
500	58
1,000	55
2,000	54
4,000	54
8,000	56

## 2.7 STARTING SYSTEM

The starting system for standby engine generator sets used in emergency applications shall be in accordance with NFPA 99 and NFPA 110 and as follows.

### 2.7.1 Controls

An engine control switch shall be provided with functions including: run/start (manual), off/reset, and automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cool down operation. The logic shall be arranged for manual starting and fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR SET SYSTEM OPERATION. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

### 2.7.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15-second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

### 2.7.3 Functional Requirements

Starting system shall be manufacturers recommended dc system utilizing a negative circuit ground. Starting motors shall be in accordance with SAE ARP 892.

### 2.7.4 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, and spacers. The battery shall be in accordance with SAE J 537. The battery shall be nickel-cadmium type, with sufficient capacity, at the minimum outdoor winter temperature specified to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

### 2.7.5 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize charging rate for recharging fully depleted

batteries within 24 hours and a float charge rate for maintaining the batteries in prime starting condition. An ammeter shall be provided to indicate charging rate. A timer shall be provided for the equalize charging rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

#### 2.7.6 Starting Aids

The manufacturer shall provide one or more of the following methods to assist engine starting.

##### 2.7.6.1 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified.

#### 2.8 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100% of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine generator set, without special tools, from 90 to 110 % of the rated speed/frequency, over a steady state load range of zero to 100% of rated capacity. Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100% of rated output capacity.

#### 2.9 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class H. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 100 percent. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type.

##### 2.9.1 Current Balance

At 100 percent rated load, and load impedance equal for each of the three phases, the permissible current difference between any two phases shall not exceed 2 percent of the largest current on either of the two phases.

##### 2.9.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated load, the difference in line-to-neutral voltage among the three phases shall not exceed 1 percent of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other two phases, the maximum simultaneous difference in line-to-neutral voltage

between the phases shall not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

#### 2.9.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced full rated load at 0.8 power factor shall not exceed 10%. The RMS of all harmonics shall be less than 5.0% and that of any one harmonic less than 3.0% at full rated load. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE Std 519.

#### 2.10 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300% for peak inverse voltage and forward current ratings for all operating conditions, including 110% generator output at 104 degrees F ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified.

#### 2.11 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter. The regulator shall maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100% of rated output capacity. Regulator shall be configured for safe manual adjustment of the engine generator voltage output without special tools, during operation from 90 to 110% of the rated voltage over the steady state load range of zero to 100% of rated output capacity. Regulation drift shall not exceed plus or minus 0.5% for an ambient temperature change of 36 degrees F.

##### 2.11.1 Steady State Performance (Regulation or Voltage Droop).

The voltage regulator shall have a maximum droop of 2% of rated voltage over a load range from 0 to 100% of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

#### 2.12 GENERATOR PROTECTION

Short circuit and overload protection for the generator shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit and interrupting current ratings to match the generator capacity. The manufacturer shall determine the short circuit current interrupting rating of the breaker. The breaker shall be engine generator base mounted by the engine-generator set manufacturer. Molded case breakers shall be provided with shunt trip. Surge protection shall be provided for each phase of the generator, to be mounted at the generator terminals.

#### 2.13 SAFETY SYSTEM

Devices, wiring, remote panels, local panels, etc., shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be

provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgement and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element.

#### 2.13.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

#### 2.13.2 Visual Signal Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously light upon acknowledgment. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

#### 2.13.3 Alarms and Action Logic

##### 2.13.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers shall be accomplished.

##### 2.13.3.2 Problem

Activation of the visual signal shall be accomplished.

#### 2.13.4 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions 110 level 1 and including the listed Corps of Engineers requirements, mounted either on or adjacent to the engine generator set.

Device/ Condition/	What/Where/Size	NFPA 110 Level 1 Required	Corps of Engrs Function
Shutdowns W/Alarms			
High engine temperature	Automatic/ jacket water/ cylinder	SD/CP VA	SD VA
Low lube-oil pressure	Automatic/ pressure/ level	SD/CP VA	SD VA
Overspeed shutdown \$ alarm	(110% (+ 2%) of rated speed	SD/CP VA	SD VA

Device/ Condition/	What/Where/Size	NFPA 110 Level 1 Required	Corps of Engrs Function
Overcrank failure to start	Automatic/ Failure to to start	SD/CP VA	
Air shutdown damper (200-600kW)	When used	SD/CP VA	
Day tank overflow limit indication & transfer pump shutdown (95% volume)	Automatic/Day Tank/Level		SD/OPA (Pump)
Red emergency stop switch	Manual Switch	SD/CP VA	SD VA
Failure to crank	Corps of Engrs. Required		
Day tank Integral Main Fuel Tank low fuel limit Device/ Condition/ indication (70% volume remaining)	Corps of Engrs. Required		
Alarms			
Low lube-oil pressure	Pressure/ level	CP VA	CP VA
Low fuel level	Main tank, 3 hours remaining	CP VA	
High fuel level	Integral Main Fuel Storage Tank 95% Volume		CP VA
Low coolant	Jacket water	CP VA	
Pre-high temperature	Jacket water/ cylinder	CP VA	CP VA
Pre-low lube-oil pressure			CP VA

Device/ Condition/	What/Where/Size	NFPA 110 Level 1 Required	Corps of Engrs Function
High battery voltage		CP VA	
Low battery voltage		CP VA	
Battery charger AC failure	AC supply not available	CP VA	
Control switch not in AUTO		CP VA	
Low starting air pressure		CP VA	
Low starting hydraulic pressure		CP VA	
SD - Shut Down			
CP - On Control Panel			
VA - Visual Alarm			
AA - Audible Alarm			
O - Optional			

#### 2.13.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

#### 2.13.6 Remote Alarm Panel

A remote alarm panel shall be provided in accordance with NFPA 110 and as follows:

Device/Condition/ Function	What/Where/Size	NFPA 110 Level 1
Remote annunciator panel	Battery powered	Alarms
Loads on genset		
Battery charger malfunction		
Low lube-oil	Pressure/level	AA
Low Temperature	Jacket water	AA
High Temperature	Jacket water/	AA

Device/Condition/	What/Where/Size cylinder	NFPA 110
Low fuel level	Main tank, 3 hr remaining	AA
Overcrank	Failure to start	AA
Overspeed		AA
Pre-high temperature	Jacket water/ cylinder	AA
Control switch not in AUTO		AA
Common alarm contacts for local & remote common alarm		X
Audible alarm silencing switch		X
Common fault alarm		AA
X - Required SD - Shut Down CP - On Control Panel VA - Visual Alarm AA - Audible Alarm O - Optional		

#### 2.14 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc., shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

#### 2.15 PANELS

##### 2.15.1 Exerciser

The exerciser shall be in accordance with Section 16410A AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

#### 2.16 SURGE PROTECTION

Electrical and electronic components shall be protected from, or designed to withstand the effects of surges from switching and lightning.

#### 2.17 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and source transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; and stopping of each engine-generator set after cool down. Devices shall automatically reset after termination of their function.

### 2.17.1 Automatic Transfer Switch

Automatic transfer switches shall be in accordance with Section 16410A AUTOMATIC TRANSFER SWITCH.

### 2.17.2 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 16410A AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

### 2.18 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of all rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment will be maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall be provided with suitable holes for foundation bolts. The base shall also withstand and mitigate the effects of synchronous vibration of the engine and generator, and shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

### 2.19 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted in accordance with the manufacturer's standard color and practice.

### 2.20 FACTORY INSPECTION AND TESTS

Factory inspection and tests shall be performed on each engine-generator set proposed to meet this specification section. Inspections shall be completed and necessary repairs made prior to testing. Inspectors shall look for leaks, looseness, defects in components, and proper assembly. Factory tests shall be NEMA MG 1 routine tests and the manufacturers routine tests.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

### 3.2 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 16415A ELECTRICAL WORK, INTERIOR.

#### 3.2.1 Vibration Isolation

Flexible fittings shall be provided for all conduit and raceways attached to engine-generator sets. Metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor.



Terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

### 3.3 ONSITE INSPECTION AND TESTS

#### 3.3.1 Test Conditions

##### 3.3.1.1 Data

Measurements shall be made and recorded of parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments or replacements shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be taken during engine-generator set operation and recorded in 15 minute intervals and shall include: readings of engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions and terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE Std 1.

##### 3.3.1.2 Power Factor

Engine-generator set operating tests shall be made utilizing a load with the power factor specified in the engine generator set parameter schedule.

##### 3.3.1.3 Contractor Supplied Items

The Contractor shall provide all equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

##### 3.3.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments, provided under this specification shall be verified during test runs by test instruments of precision and accuracy greater than the tested items. Test instrument accuracy shall be at least as follows: current, 1.5%; voltage, 1.5%; real power, 1.5%; reactive power, 1.5%; power factor, 3%; frequency, 0.5%. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

##### 3.3.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however the following general order of testing shall be followed: Construction Tests; Inspections; Safety run Tests; and Performance Tests and Final Inspection.

### 3.3.2 Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1. Drive belts. (I)
2. Governor type and features. (I)
3. Engine timing mark. (I)
4. Starting motor. (I)
5. Starting aids. (I)
6. Coolant type and concentration. (D)
7. Radiator drains. (I)
8. Block coolant drains. (I)
9. Coolant fill level. (I)
10. Coolant line connections. (I)
11. Coolant hoses. (I)
12. Combustion air filter. (I)
13. Intake air silencer. (I)
14. Lube oil type. (D)
15. Lube oil drain. (I)
16. Lube-oil filter. (I)
17. Lube-oil-fill level. (I)
18. Lube-oil line connections. (I)
19. Lube-oil lines. (I)
20. Fuel type. (D)
21. Fuel-level. (I)
22. Fuel-line connections. (I)
23. Fuel lines. (I)
24. Fuel filter. (I)
25. Access for maintenance. (I)
26. Voltage regulator. (I)
27. Battery-charger connections. (I)
28. Wiring & terminations. (I)
29. Instrumentation. (I)
30. Base. (I)
31. Nameplates. (I)
32. Paint. (I)
33. Enclosure. (I)
34. Engine & generator mounting bolts (proper application). (I)

### 3.3.3 Safety Run Tests

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

- c. Activate the manual emergency stop switch and verify that the engine stops.
- d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary, provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If temperature reading exceeds the value for an alarm condition, activate the manual emergency stop switch.
- f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily seal their normal location on the engine and temporarily install temperature gauges in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set at no load until the output voltage and frequency stabilize.
- i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- k. Operate the engine generator-set for at least 30 minutes at 100 percent of service load.
- l. Verify proper operation of the governor and voltage regulator.
- m. Verify proper operation and setpoints of gauges and instruments.
- n. Verify proper operation of ancillary equipment.
- o. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.
- p. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate

the engine generator-set for at least 15 minutes at 75 percent of rated load.

- q. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine. Record the results.
- r. Attach a manifold to the engine oil system (at the oil sensor pressure port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold and its normal location on the engine temporarily sealed. The manifold shutoff valve shall be open and bleed valve closed.
- s. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of service load.
- t. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.
- u. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100% of service load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge horizontal piping; or at a radius of 75 feet from the engine at 45 degrees apart in all directions for vertical piping. The measurements should comply with the paragraph SOUND LIMITATIONS. If a sound limiting enclosure is provided, the enclosure, the muffler, and intake silencer shall be modified or replaced as required to meet the sound requirements contained within this specification. If a sound limiting enclosure is not provided, the muffler and air intake silencer shall be modified or replaced as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, the contractor shall notify the Contracting Officer and provide a recommendation for meeting the sound limitations.

#### 3.3.4 Performance Tests

##### 3.3.4.1 Continuous Engine Load Run Test

The engine-generator set and ancillary systems shall be tested at service load to: demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, with an average ambient temperature of 70 degrees F. After each change in load in the following test, measure the vibration at the end bearings (front and

back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range.

Measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.).

Stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Data taken at 15 minutes intervals shall include the following:

- a. Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.
- b. Pressure: Lube-oil.
- c. Temperature: Coolant.  
Lube-oil.  
Ambient.

(1) Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

(2) Start the engine; make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

(3) Operate the engine generator-set for at least 2 hours at 75 percent of service load.

(4) Increase load to 100% of service load and operate the engine generator-set for at least 2 hours.

(5) Remove load from the engine-generator set.

#### 3.3.4.2 Load Acceptance Test

Engine manufacturer's recommended prestarting checks and inspections shall be performed and recorded. The engine shall be started, and engine manufacturer's after-starting checks and inspections made and recorded during a reasonable warm-up period. For the following steps, the output line-line and line-neutral voltages and frequency shall be recorded after performing each step instruction (after stabilization of voltage and frequency). Stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings.

- a. Apply load in steps no larger than the Maximum Step Load Increase to load the engine-generator set to 100 of Service Load.
- b. Verify that the engine-generator set responds to the load addition and that the output voltage returns to and stabilizes within the rated bandwidths.

#### 3.3.5 Automatic Operation Tests for Stand-Alone Operation

The automatic loading system shall be tested to demonstrate automatic starting, and loading and unloading of each engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a

minimum of two successive, successful tests. Data taken shall include the following:

- a. Ambient temperature (at 15 minute intervals).
- b. Generator output current (before and after load changes).
- c. Generator output voltage (before and after load changes).
- d. Generator output frequency (before and after load changes).
  - 1) Initiate loss of the primary power source and verify automatic sequence of operation.
  - 2) Restore the primary power source and verify sequence of operation.
  - 3) Verify resetting of controls to normal.

### 3.4 FINAL INSPECTION AND TESTING

- a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. Increase the load in steps no greater than the maximum step load increase to 100% of service load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.
- c. Remove load and shut down the engine-generator set after the recommended cool down period. Perform the pre-test inspections and take necessary corrective actions.
- d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 4 hours at service load, then re-examining the oil and filter.
- e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.
- f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.
- g. Replace air, oil, and fuel filters with new filters.

### 3.5 MANUFACTURER'S FIELD SERVICE

#### 3.5.1 Onsite Training

The Contractor shall conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. The course

instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations such as oil change, oil filter change, and air filter change.

#### 3.5.2 Manufacturer's Representative

The engine generator-set manufacturer shall furnish a qualified representative to supervise the installation of the engine generator-set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment.

#### 3.6 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

-- End of Section --

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## SECTION 16370A

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07/02

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## SECTION 16370A

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL  
07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.1	(1999) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C135.2	(1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
ANSI C135.22	(1988) Galvanized Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
ANSI C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
ANSI C29.2	(1992; R 1999) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.4	(1989; R 2002) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(1984; R 2002) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1996; R 2002) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI C29.8	(1985; R 2002) Apparatus, Cap and Pin Type Wet-Process Porcelain Insulators -
ANSI C29.9	(1983; R 2002) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
ANSI O5.1	(2002) Specifications and Dimensions for

## Wood Poles

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C25	(2001) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA C4	(1999) Poles - Preservative Treatment by Pressure Processes
AWPA P1/P13	(2001) Standard for Creosote Preservative
AWPA P5	(2002) Standard for Waterborne Preservatives
AWPA P8	(2001) Standard for Oil-Borne Preservatives
AWPA P9	(2001) Standards for Solvents and Formulations for Organic Preservative Systems

## ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 575	(1996; R 2002) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 2000) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(2001) Hard-Drawn Copper Wire
ASTM B 117	(2002) Operating Salt Spray (Fog) Apparatus
ASTM B 232/B 232M	(2001e1) Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B 416	(1998; R 2002) Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2002) National Electrical Safety Code
IEEE C57.19.00	(1991; R 1997) Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings

IEEE C57.19.01	(2000) Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
IEEE C62.1	(1989; R 1994) Gapped Silicon-Carbide Surge Arresters for AC Power Circuits
IEEE C62.11	(1999) Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1KV)
IEEE Std 100	(2000) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) Normal Measurements

## INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-70-547	(2000) Weather Resistant Polyethylene Covered Conductors
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## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA HV 2	(1991; R 1996; R 2002) Application Guide for Ceramic Suspension Insulators
NEMA LA 1	(1992; R 1999) Surge Arresters
NEMA SG 2	(1993) High Voltage Fuses

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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## U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1728H-701	(1993) Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys
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## UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; Rev thru Feb 2001) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru May 2001) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev thru May 2001) Wire Connectors for Use with Aluminum Conductors

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. A designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Electrical Distribution System; G, RE

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

- a. Poles.
- b. Crossarms.
- c. Conductors.
- d. Insulators.
- e. Surge arresters.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

- a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.
- b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

#### As-Built Drawings

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

##### Material and Equipment

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

##### General Installation Requirements

As a minimum, installation procedures for regulators, transformers and reclosers. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

#### SD-06 Test Reports

##### Factory Tests

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

##### Field Testing

A proposed field test plan 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

##### Operating Tests; G, RE

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings, and including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

#### SD-07 Certificates

##### Material and Equipment

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

## 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

### 2.2 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 2.3 CORROSION PROTECTION

#### 2.3.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

#### 2.3.2 Ferrous Metal Materials

##### 2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

##### 2.3.2.2 Equipment

Equipment and component items shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.4 CONDUCTORS, CONNECTORS, AND SPLICES

#### 2.4.1 Aluminum-Composition Conductors

Aluminum-conductor-steel-reinforced, ACSR, shall comply with ASTM B 232/B 232M.



#### 2.4.2 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

#### 2.4.3 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum-composition to copper shall comply with UL 486B, and copper-to-copper shall comply with UL 486A.

### s2.5 MEDIUM-VOLTAGE LINES

#### 2.5.1 Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall be aluminum-conductor-steel-reinforced, ACSR;. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

### 2.6 LOW-VOLTAGE LINES

Low-voltage line conductors shall be of the neutral-supported secondary and service drop type with thermoplastic insulation, weather-resistant polyolefin-covered type conforming to ICEA S-70-547. Neutral-supported secondary and service drop conductors shall be insulated copper with bare hard-drawn-copper or copper-clad steel neutrals.

### 2.7 POLES AND HARDWARE

Poles shall be of lengths and classes indicated.

#### 2.7.1 Wood Poles

Wood poles shall comply with ANSI O5.1, and shall be pressure treated in accordance with AWPA C4, with creosote conforming to AWPA P1/P13or with oil-borne preservatives and petroleum conforming to AWPA P8 and AWPA P9, respectively, and waterborne preservatives conforming to AWPA P5. Waterborne preservatives shall be either chromated or ammoniacal copper arsenate. Any species listed in ANSI O5.1 for which a preservative treatment is not specified in AWPA C4, shall not be used; northern white cedar, if treated as specified for western red cedar, and western fir, if treated as specified for Douglas fir, may be used. Wood poles shall have pole markings located approximately 10 feet from pole butts for poles 50 feet or less in length. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, gained, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

#### 2.7.2 Pole Line Hardware

Zinc-coated hardware shall comply with ANSI C135.1, ANSI C135.2, ANSI C135.4, ANSI C135.14 ANSI C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M. Pole-line hardware shall be hot-dip galvanized steel. Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall

be approximately 2-1/4 inches square and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

#### 2.7.3 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to ANSI C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

#### 2.7.4 Guy Assemblies

Guy assemblies shall be aluminum-clad steel in accordance with ASTM B 416. Guy assemblies, including insulators and attachments, shall provide a strength exceeding the required guy strength. Three-eye thimbles shall be provided on anchor rods to permit attachment of individual primary, secondary, and communication down guys. Anchors shall provide adequate strength to support all loads. Guy strand shall be 7 strand. Guy material shall be high-strength, with a minimum breaking strength not less than 6000 pounds. Guy rods shall be not less than 8 feet in length by 3/4 inch in diameter.

### 2.8 INSULATORS

Insulators shall comply with NEMA HV 2 for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

#### 2.8.1 Medium-Voltage Line Insulators

Medium-voltage line insulators shall comply with ANSI C29.2, ANSI C29.5, and ANSI C29.6, and as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.

TABLE I

## MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
6 kV to 15 kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4

## 2.8.2 Strain Insulators for Guy Wires

Strain insulators for use in insulated guy assemblies shall comply with ANSI C29.4 for porcelain or equivalent fiberglass, and shall have a mechanical strength exceeding the rated breaking strength of the attached guy wire. Insulators shall be smaller than Class 54-3 for lines of 6 kV to 15 kV.

## 2.8.3 Apparatus Insulators

Apparatus insulators shall comply with IEEE C57.19.00, IEEE C57.19.01, ANSI C29.8, and ANSI C29.9 as applicable.

## 2.9 CROSSARM ASSEMBLIES

## 2.9.1 Crossarms

Crossarms shall comply with RUS Bull 1728H-701 and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWP C25, and a 1/4 inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

## 2.10 FUSES AND SWITCHES, MEDIUM-VOLTAGE

## 2.10.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the loadbreak type construction rated 15 kV and of the ratings and types to match the existing to be demolished. Fuses shall be either indicating or dropout type. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

## 2.11 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, ANSI C62.2, and IEEE C62.11, and shall be provided for protection of transformers and other indicated equipment. Arresters shall be distribution class, rated as shown. Arresters shall be of the valve or metal-oxide varistor or combination valve-metal-oxide varistor type suitable for outdoor

installations.

## 2.12 GROUNDING AND BONDING

### 2.12.1 Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

### 2.12.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of IEEE C2 for medium loading districts, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of NFPA 70.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

### 3.2 POLE INSTALLATION

#### 3.2.1 Wood Pole Setting

Wood Pole Setting: Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. In rocky or swampy ground, pole-setting depths shall be decreased or increased respectively in accordance with the local utility's published standards and as approved. In swampy or soft ground, a bog shoe shall be used where support for a pole is required. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations,

and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into the hole in 6 inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around each pole in a conical shape and packed tightly to drain water away from poles.

TABLE II

## MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5.0	5.0
25	5.5	5.5
30	5.5	5.5
35	6.0	6.0
40	6.5	6.5
45	6.5	7.0
50	7.0	7.5
55	7.5	8.0
60	8.0	8.5

## 3.3 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts.

## 3.3.1 Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

## 3.4 GUY INSTALLATION

Guys shall be provided where shown, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8 inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. Guy-strain insulators

shall be provided in each guy for wood poles. Multiple-helix screw anchors shall be provided in marshy ground; rock anchors shall be installed in rock at right angles to guys, elsewhere anchors shall be of an expanding type, except that power installed screw anchors of equivalent holding power are acceptable. A half-round yellow polyvinyl, fiberglass, or other suitable plastic guy marker, not less than 8 feet in length, shall be provided at the anchor end of each guy shown, securely clamped to the guy or anchor at the bottom and top of the marker. Holding capacities for down guys shall be based on a lead angle of 45 degrees.

### 3.5 CONDUCTOR INSTALLATION

#### 3.5.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

#### 3.5.2 Connectors and Splices

Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

#### 3.5.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in TABLE II.

TABLE II

## TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any	6 or 4

## 3.5.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

## 3.5.5 Low-Voltage Insulated Cables

Low-voltage cables shall be supported on clevis fittings using spool insulators. Dead-end clevis fittings and suspension insulators shall be provided where required for adequate strength. Dead-end construction shall provide a strength exceeding the rated breaking strength of the neutral messenger. Clevis attachments shall be provided with not less than 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 200 feet. Secondary racks shall be two-, three-, or four-wire, complete with spool insulators. Racks shall meet strength and deflection requirements for heavy-duty steel racks, and shall be either galvanized steel or aluminum alloy. Tops of insulator saddles shall be rounded and smooth to avoid damage to conductor insulation. Each insulator shall be held in place with a 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four No. 4/0 AWG or four larger conductors shall be attached to poles with three 5/8 inch through-bolts. Other secondary racks shall be attached to poles with at least two 5/8 inch through-bolts. Minimum vertical spacing between conductors shall not be less than 8 inches.

## 3.6 TRANSFORMER INSTALLATION

Existing transformers shall be carefully installed so as not to scratch finishes or damage bushings. Transformers shall be installed in accordance with the manufacturer's instructions.

### 3.7 CONNECTIONS TO UTILITY LINES

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the installation electric lines.

### 3.8 CONNECTIONS TO BUILDINGS

#### 3.8.1 Aerial Services

Connections to buildings shall be made at approximately the point indicated and shall be connected to the service entrance conductors. Use existing supports if adequate to withstand required pulls; if not adequate, provide new supports. Drip loops shall be formed on conductors at entrances to buildings, cabinets, or conduits. Service-entrance conduits with termination fittings and conductors within the building, including sufficient slack for connection to aerial service cables, shall conform to the requirements of Section 16415A ELECTRICAL WORK, INTERIOR.

### 3.9 GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as transformers and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where required or indicated.

#### 3.9.1 Grounding Electrodes

Grounding electrodes shall be installed as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.
- b. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance.

#### 3.9.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

### 3.10 FIELD TESTING

#### 3.10.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 15 days prior to conducting tests. The Contractor shall furnish materials, labor, and



equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

Field reports will be signed and dated by the Contractor.

#### 3.10.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.10.3 Ground-Resistance Tests

The resistance of each pole ground shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

#### 3.10.4 Sag and Tension Test

The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

#### 3.10.5 Pre-Energization Services

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

#### 3.10.6 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance

with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

### 3.11 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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## SECTION 16375A

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## SECTION 16375A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND  
02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C119.1	(2002) For Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C12.10	(2004) Physical Aspects of Watthour Meters - Safety Standard
ANSI C12.11	(1987; R 2002) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C12.4	(1984; R 2002) Mechanical Demand Registers
ANSI C57.12.21	(1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)
ANSI C57.12.26	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVA and Smaller

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 48/A 48M	(2003) Gray Iron Castings
ASTM B 117	(2003) Operating Salt Spray (Fog) Apparatus
ASTM B 3	(2001) Soft or Annealed Copper Wire

ASTM B 496	(2004) Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM B 8	(2004) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM C 478	(2003a) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(2003a) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

## ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994; CS5a-1995) Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2002) National Electrical Safety Code
IEEE C57.12.00	(2000) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(1993) Instrument Transformers
IEEE C57.98	(1994; R 1999) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for AC Power Circuits
IEEE C62.11	(1999) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE Std 100	(2001) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 386	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 404	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V

Through 500 000 V

IEEE Std 48 (1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV

IEEE Std 592 (1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) \\\\$31.00\$\\F

#### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LA 1 (1992; R 1999) Surge Arresters

NEMA TC 6 (2003) PVC and ABS Plastic Utilities Duct for Underground Installation

NEMA WC 7 (1988; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1988; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

#### UNDERWRITERS LABORATORIES (UL)

UL 1072 (2001) Medium Voltage Power Cables

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL 486A (2003) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (2003) Wire Connectors for Use with Aluminum Conductors

UL 651 (1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.



### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Electrical Distribution System; G, RE

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

c. Manholes/handholes.

d. Surge arresters.

#### As-Built Drawings

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

##### Nameplates

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

##### Material and Equipment

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

##### General Installation Requirements; G, RE

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

#### SD-06 Test Reports

##### Factory Tests

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

### Field Testing

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

### Operating Tests

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

### Cable Installation

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

### SD-07 Certificates

#### Material and Equipment

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be

constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements.

The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

#### Cable Joints

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

#### Cable Installer Qualifications

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

### SD-10 Operation and Maintenance Data

#### Electrical Distribution System

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions,

spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers shall be stored in accordance with the manufacturer's requirements. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

#### 1.6 AS-BUILT DRAWINGS

Provide full size as-built drawings to the Contracting Officer.

#### 1.7 Cable Installer Qualifications

A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

## 2.2 NAMEPLATES

### 2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. As a minimum, nameplates shall be provided for transformers.

### 2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 50 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 50 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

## 2.3 CORROSION PROTECTION

### 2.3.1 Aluminum Materials

Aluminum shall not be used.

### 2.3.2 Ferrous Metal Materials

#### 2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTS AND COATINGS.

## 2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

### 2.4.1 Medium-Voltage Cables

#### 2.4.1.1 General

Cable construction shall be Type MV, conforming to NFPA 70 and UL 1072 concentric neutral underground distribution cable conforming to AEIC CS5 and NEMA WC 7. Cables shall be manufactured for use in duct applications.

#### 2.4.1.2 Ratings

Cables shall be rated for a circuit voltage of 15 kV.

#### 2.4.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding.

#### 2.4.1.4 Insulation

Cable insulation shall be ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6. A 133 percent insulation level shall be used on 15 kV rated cables.

#### 2.4.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase. The shield tape shall be sized to meet IEEE C2 requirements for a ground fault availability of 10,000 amperes.

#### 2.4.1.6 Jackets

Cables shall be provided with a PVC jacket. Direct buried cables shall be rated for direct burial.

### 2.4.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

#### 2.4.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8. Intermixing of copper and aluminum conductors is not permitted.

#### 2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

#### 2.4.2.3 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

### 2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

#### 2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592.

Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure-filled type utilizing a plastic-tape mold is acceptable. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

#### 2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

#### 2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B.

Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

#### 2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal



infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

#### 2.5.4.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level.

### 2.6 CONDUIT AND DUCTS

Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage lines. Low-voltage lines run from pad-mounted transformer's secondary to service equipment may be direct-burial using thick-wall type duct.

#### 2.6.1 Nonmetallic Ducts

##### 2.6.1.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

##### 2.6.1.2 Direct Burial

UL 651, thick wall, Schedule 80.

#### 2.6.2 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

### 2.7 MANHOLES, HANDHOLES, AND PULLBOXES

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48/A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

## 2.8 TRANSFORMERS

Transformers shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV between phases for 133 percent insulation level.

### 2.8.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the radial or loop feed type, as indicated. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

#### 2.8.1.1 High-Voltage Compartments (Transformer T-1)

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, oil-immersed, bayonet-type, overload fuse in series with a partial range current-limiting fuse, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stenciled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert.

#### 2.8.1.2 Load-Break Switch (Transformer T-1)

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment. Operation of switches shall be as follows:

ARRANGEMENT #	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION		
		LINE A SW OPEN CLOSE	LINE B SW OPEN CLOSE	XFMR SW OPEN CLOSE
1	Line A connected to Line B and both lines connected to transformer	X	X	X

ARRANGEMENT #	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION			
		LINE A SW		LINE B SW	
		OPEN	CLOSE	OPEN	CLOSE
2	Transformer connected to Line A only		X	X	
3	Transformer connected to Line B only	X			X
4	Transformer open and loop closed		X	X	
5	Transformer open and loop open	X		X	

#### 2.8.1.3 Transformer Tank Sections (Transformer T-1)

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.....750 kVA.

Impedance.....5.75.

Temperature Rise.....65 degrees C.

High-voltage winding.....13.8 volts.

High-voltage winding connections.....Delta.

Low-voltage winding.....480 volts.

Low-voltage winding connections.....wye.

#### 2.8.1.4 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary. Provide required terminations to accommodate building feeder as well as fire pump feeder.

#### 2.8.1.5 Accessories (Transformer T-1)

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. A drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

#### 2.8.1.6 High-Voltage Compartments (Transformer T-2)

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, oil-immersed, bayonet-type, overload fuse in series with a partial range current-limiting fuse, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stenciled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert.

#### 2.8.1.7 Load-Break Switch (Transformer T-2)

Radial-feed oil-immersed type rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

#### 2.8.1.8 Transformer Tank Sections (Transformer T-2)

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.....750 kVA.

Impedance.....5.75.

Temperature Rise.....65 degrees C.

High-voltage winding.....13.8 volts.

High-voltage winding connections.....Delta.

Low-voltage winding.....480 volts.

Low-voltage winding connections.....wye.

#### 2.8.1.9 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

#### 2.8.1.10 Accessories (Transformer T-2)

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. A drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

### 2.9 METERING AND PROTECTIVE DEVICES

#### 2.9.1 Instrument Transformers

##### 2.9.1.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

##### 2.9.1.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall not be less than 2.0. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accident open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

##### 2.9.1.3 Current Transformers for Kwh and Demand Metering (Low-Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through B-0.5, with a minimum RF of 2.0 at 30 degrees C, with 600-volt insulations, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted on the transformer low-voltage bushings. Route current transformer leads in a

location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters.

#### 2.9.2 Watthour Meters

Watthour meters shall conform to ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the socket mounted outdoor type having a 30 minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than 2-1/2 staters. Watthour demand meters shall have factory-installed electronic pulse initiators. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of 1 pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.

#### 2.10 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided at transformer's primary compartment. Arresters shall be dead-front type. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type.

#### 2.11 GROUNDING AND BONDING

##### 2.11.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

##### 2.11.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

#### 2.12 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 02754A CONCRETE PAVEMENTS FOR SMALL PROJECTS.

#### 2.13 PADLOCKS

Padlocks shall comply with Section 08710 DOOR HARDWARE.

#### 2.14 LIQUID DIELECTRICS

Liquid dielectrics for transformers shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1,

2, 4 trichlorobenzene fluids shall not be used.

## 2.15 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

- a. Transformers: Manufacturer's standard routine design tests in accordance with IEEE C57.12.00.
- b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE C57.98.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02300 EARTHWORK. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 3.2 CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

#### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

#### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.



- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

### 3.2.2 Duct Line

Medium-voltage cables and Low-voltage cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

### 3.2.3 Existing Electric Manhole (PM7)

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

## 3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

## 3.4 DUCT LINES

### 3.4.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

### 3.4.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during

construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.4.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

#### 3.4.4 Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth of 30 inches, but not less than 48 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be free of stones, soft spots, and sharp objects.

Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

#### 3.4.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

##### 3.4.5.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

#### 3.4.6 Duct Line Markers

Duct line markers shall be provided as indicated. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

### 3.5 MANHOLES, HANDHOLES, AND PULLBOXES

#### 3.5.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

#### 3.5.2 Communications Manholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone manhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others.

#### 3.5.3 Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

#### 3.5.4 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 1/2 inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage" and provided with 2 lifting eyes and 2

hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

### 3.5.5 Ground Rods

A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

## 3.6 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase transformers shall be installed with A, B, C phase sequence. Primary taps shall be set at zero.

### 3.6.1 Concrete Pads

#### 3.6.1.1 Construction

Concrete pads for pad-mounted electrical equipment shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

#### 3.6.1.2 Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 02754A CONCRETE PAVEMENTS FOR SMALL PROJECTS.

#### 3.6.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other

foreign matter.

### 3.6.2 Padlocks

Padlocks shall be provided for pad-mounted equipment. Padlocks shall be keyed as directed by the Contracting Officer.

### 3.7 GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer to the ground ring. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

#### 3.7.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.
- b. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 12 inches, plus or minus 3 inches, below finished top of soil grade. Ground ring conductors shall be sized as shown.
- c. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three, 10 foot rods spaced a minimum of 10 feet apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

#### 3.7.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process.

#### 3.7.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

#### 3.7.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

#### 3.7.5 Handhole, or Concrete Pullbox Grounding

Ground rods installed in handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to handhole walls and the amount of exposed bare wire shall be held to a minimum.

### 3.8 FIELD TESTING

#### 3.8.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

#### 3.8.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.8.3 Ground-Resistance Tests

The resistance of the ground ring shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Ground ring - 5 ohms.

#### 3.8.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

#### 3.8.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

#### 3.8.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- c. Correct phase sequence.
- d. Correct operation of tap changer.

#### 3.8.7 Pre-Energization Services

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. Items for which such services shall be provided, but are not limited to, are the following:

a. Pad-mounted transformers

3.8.8 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3.9 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --



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DIVISION 16 - ELECTRICAL

SECTION 16410A

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07/01

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## SECTION 16410A

AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH  
07/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117 (2003) Operating Salt Spray (Fog) Apparatus

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13 (1990; R 1995) Low-Voltage AC Power  
Circuit Breakers Used in Enclosures

IEEE C37.90.1 (2002) IEEE Standard Surge Withstand  
Capability (SWC) Tests for Protective  
Relays and Relay Systems

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

IEEE Std 602 (1996) Electric Systems in Health Care  
Facilities

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (2000) Industrial Controls and Systems  
General Requirements

NEMA ICS 2 (1996) Industrial Controls and Systems  
Controllers, Contactors, and Overload  
Relays Rated Not More Than 2,000 Volts AC  
or 750 Volts DC

NEMA ICS 4 (2000) Industrial Control and Systems  
Terminal Blocks

NEMA ICS 6 (1993; R 2001) Industrial Control and  
Systems, Enclosures

NEMA ICS 10 (1999) Industrial Control and Systems: AC  
Transfer Switch Equipment - Part 2:  
Static AC Transfer Equipment

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 110 (2002) Emergency and Standby Power Systems  
UNDERWRITERS LABORATORIES (UL)

UL 1008 (1996; Rev thru Feb 1999) Transfer Switch  
Equipment

UL 1066 (1997) Low-Voltage AC and DC Power Circuit  
Breakers Used in Enclosures

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Automatic Transfer Switch; G, RE

Schematic, external connection, one-line schematic and wiring diagram of each ATS assembly. Interface equipment connection diagram showing conduit and wiring between ATS and related equipment. Device, nameplate, and item numbers shown in list of equipment and material shall appear on drawings wherever that item appears. Diagrams shall show interlocking provisions and cautionary notes, if any. Operating instructions shall be shown either on one-line diagram or separately. Unless otherwise approved, one-line and elementary or schematic diagrams shall appear on same drawing.

Equipment  
Installation

Dimensioned plans, sections and elevations showing minimum clearances, weights, and conduit entry provisions for each ATS.

### SD-03 Product Data

Material  
Equipment

List of proposed equipment and material, containing a description of each separate item.

### SD-06 Test Reports

Testing

A description of proposed field test procedures, including proposed date and steps describing each test, its duration and expected results, not less than 2 weeks prior to test date.

Certified factory and field test reports, within 14 days following completion of tests. Reports shall be certified and dated and shall demonstrate that tests were successfully completed prior to shipment of equipment.

## SD-07 Certificates

Equipment  
Material

Certificates of compliance showing evidence of UL listing and conformance with applicable NEMA standards. Such certificates are not required if manufacturer's published data, submitted and approved, reflect UL listing or conformance with applicable NEMA standards.

## Switching Equipment

Evidence that ATS withstand current rating (WCR) has been coordinated with upstream protective devices as required by UL 1008. Upon request, manufacturer shall also provide notarized letter certifying compliance with requirements of this specification, including withstand current rating.

## SD-10 Operation and Maintenance Data

Switching Equipment  
Instructions

Six copies of operating manual outlining step-by-step procedures for system startup, operation, and shutdown. Manual shall include manufacturer's name, model number, service manual, parts list, and brief description of equipment and basic operating features. Manufacturer's spare parts data shall be included with supply source and current cost of recommended spare parts. Six copies of maintenance manual listing routine maintenance, possible breakdowns, repairs, and troubleshooting guide. Manual shall include simplified wiring and control diagrams for system as installed.

## 1.3 GENERAL REQUIREMENTS

## 1.3.1 Standard Product

Material and equipment shall be standard products of a manufacturer regularly engaged in manufacturing the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The experience use shall include applications in similar circumstances and of same design and rating as specified ATS. Equipment shall be capable of being serviced by a manufacturer-authorized and trained organization that is, in the Contracting Officer's opinion, reasonably convenient to the site. Provide short circuit rating of switching equipment.

## 1.3.2 Nameplate

Nameplate showing manufacturer's name and equipment ratings shall be made of corrosion-resistant material with not less than 1/8 inch tall characters. Nameplate shall be mounted to front of enclosure and shall comply with nameplate requirements of NEMA ICS 2.

## PART 2 PRODUCTS

## 2.1 AUTOMATIC TRANSFER SWITCH (ATS)

ATS shall be electrically operated and mechanically held in both operating positions. ATS shall be suitable for use in standby systems described in NFPA 70. ATS shall be UL listed. ATS shall be manufactured and tested in accordance with applicable requirements of IEEE C37.90.1, IEEE C37.13, IEEE C62.41, IEEE Std 602, NEMA ICS 1, NEMA ICS 2, NEMA ICS 10, UL 1008 and UL 1066. ATS shall conform to NFPA 110. To facilitate maintenance, manufacturer's instruction manual shall provide typical maximum contact voltage drop readings under specified conditions for use during periodic maintenance. Manufacturer shall provide instructions for determination of contact integrity. ATS shall be rated for continuous duty at specified continuous current rating. ATS shall be fully compatible and approved for use with BP/IS specified. BP/IS shall be considered part of ATS system. ATS shall have characteristics as indicated on Plans; refer to sheet E-81, and as follows:

- a. Nonwelding Contacts: Rated for nonwelding of contacts when used with upstream feeder overcurrent devices shown and with available fault current specified.
- b. Main Contacts: Contacts shall have silver alloy composition.

## 2.1.1 Override Time Delay

Time delay to override monitored source deviation shall be adjustable from 0.5 to 6 seconds and factory set at 1 second. ATS shall monitor phase conductors to detect and respond to sustained voltage drop of 15 percent of nominal between any two preferred source conductors and initiate transfer action to alternate source and start engine driven generator after set time period. Pickup voltage shall be adjustable from 85 to 100 percent of nominal and factory set at 90 percent. Dropout voltage shall be adjustable from 75 to 98 percent of pickup value and factory set at 85 percent of nominal.

## 2.1.2 Transfer Time Delay

Time delay before transfer to alternate power source shall be adjustable from 0 to 5 minutes and factory set at 0 minutes. ATS shall monitor frequency and voltage of alternate power source and transfer when frequency and voltage are stabilized. Pickup voltage shall be adjustable from 85 to 100 percent of nominal and factory set at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal and factory set at 90 percent.

## 2.1.3 Return Time Delay

Time delay before return transfer to preferred power source shall be adjustable from 0 to 30 minutes and factory set at 30 minutes. Time delay shall be automatically defeated upon loss or sustained undervoltage of alternate power source, provided that preferred supply has been restored.

## 2.1.4 Engine Shutdown Time Delay

Time delay shall be adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

#### 2.1.5 Exerciser

Provide a generator exerciser timer. Run times shall be user programmable.

The generator exerciser shall be selectable between load transfer and engine run only, and shall have a fail-safe feature that will retransfer the ATS to preferred during the exercise period.

#### 2.1.6 Auxiliary Contacts

Two normally open and two normally closed auxiliary contacts rated at 15 amperes at 120 volts shall operate when ATS is connected to preferred power source, and two normally open and two normally closed contacts shall operate when ATS is connected to alternate source.

#### 2.1.7 Supplemental Features

ATS shall be furnished with the following:

- a. Engine start contact.
- b. Alternate source monitor.
- c. Test switch to simulate normal power outage.
- d. Voltage sensing. Pickup voltage adjustable from 85 to 100 percent of nominal; dropout adjustable from 75 to 98 percent of pickup.
- e. Means shall be provided in the ATS to insure that motor/transformer load inrush currents do not exceed normal starting currents. This shall be accomplished with either in-phase monitoring, time-delay transition, or load voltage decay sensing methods. If manufacturer supplies an in-phase monitoring system, the manufacturer shall indicate under what conditions a transfer cannot be accomplished. If the manufacturer supplies a time-delay transition system, the manufacturer shall supply recommendations for establishing time delay. If load voltage decay sensing is supplied, the load voltage setting shall be user programmable.

#### 2.1.8 Operator

Manual operator conforming to UL 1008 shall be provided, and shall incorporate features to prevent operation by unauthorized personnel. ATS shall be designed for safe manual operation under full load conditions. If manual operation is accomplished by opening the door, then a dead-front shall be supplied for operator safety.

#### 2.1.9 Green Indicating Light

A green indicating light shall supervise/provide preferred power source switch position indication and shall have a nameplate engraved PREFERRED.

#### 2.1.10 Red Indicating Light

A red indicating light shall supervise/provide alternate power source switch position indication and shall have a nameplate engraved ALTERNATE.

## 2.2 BY-PASS/ISOLATION SWITCH (BP/IS)

### 2.2.1 Design

Bypass/isolation switch (BP/IS) shall permit load by-pass to either preferred or alternate power source and complete isolation of associated ATS, independent of ATS operating position. BP/IS and associated ATS shall be products of same manufacturer and shall be completely interconnected and tested at factory and at project site as specified. BP/IS shall be manufactured, listed, and tested in accordance with paragraph AUTOMATIC TRANSFER SWITCH (ATS) and shall have electrical ratings that exceed or equal comparable ratings specified for ATS. Operating handles shall be externally operated and arranged so that one person can perform the bypass and isolation functions through the operation of a maximum of two handles within 5 seconds. The ATS shall have provisions for locking in the isolation position. Handle for manual operation shall be permanently attached to operating mechanism. BP/IS operation shall be accomplished without disconnecting switch load terminal conductors. Isolation handle positions shall be marked with engraved plates or other approved means to indicate position or operating condition of associated ATS, as follows:

- a. Indication shall be provided to show that ATS section is providing power to the load.
- b. Indication shall be provided of ATS isolation. The ATS controls shall remain functional with the ATS isolated or in bypass mode to permit monitoring of the normal power source and automatic starting of the generator in the event of a loss of the normal power source. In the isolated mode, the bypass section shall be capable of functioning as a manual transfer switch to transfer the load to either power source. The ATS shall be capable of undergoing functional operation testing without service interruption. The ATS may also be completely removed from the enclosure, if required for maintenance or repair, while the bypass section continues to power the load.

### 2.2.2 Switch Construction

Bypass/isolation switch shall be constructed for convenient removal of parts from front of switch enclosure without removal of other parts or disconnection of external power conductors. Contacts shall be as specified for associated ATS, including provisions for inspection of contacts without disassembly of BP/IS or removal of entire contact enclosure. To facilitate maintenance, manufacturer shall provide instructions for determination of contact integrity. BP/IS and associated ATS shall be interconnected with suitably sized copper bus bars silver-plated at each connection point, and braced to withstand magnetic and thermal forces created at WCR specified for associated ATS.

## 2.3 ENCLOSURE

ATS and accessories shall be installed in wall-mounted or free-standing, floor-mounted, unventilated NEMA ICS 6, Type 1, smooth sheet metal enclosure constructed in accordance with applicable requirements of UL 1066 and/or UL 1008. Metal gauge shall be not less than No. 14. Enclosure shall be equipped with at least two approved grounding lugs for grounding enclosure to facility ground system using No. 4 AWG copper conductors. Factory wiring within enclosure and field wiring terminating within enclosure shall comply with NFPA 70. If wiring is not color coded, wire

shall be permanently tagged or marked near terminal at each end with wire number shown on approved detail drawing. Terminal block shall conform to NEMA ICS 4. Terminals shall be arranged for entrance of external conductors from top and bottom of enclosure as shown. Main switch terminals, including neutral terminal if used, shall be pressure type suitable for termination of external copper conductors shown.

#### 2.3.1 Construction

Enclosure shall be constructed for ease of removal and replacement of ATS components and control devices from front without disconnection of external power conductors or removal or disassembly of major components. Enclosure of ATS with BP/IS shall be constructed to protect personnel from energized BP/IS components during ATS maintenance.

#### 2.3.2 Cleaning and Painting

Both the inside and outside surfaces of an enclosure, including means for fastening, shall be protected against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means. Protection is not required for metal parts that are inherently resistant to corrosion, bearings, sliding surfaces of hinges, or other parts where such protection is impractical. Finish shall be manufacturer's standard material, process, and color and shall be free from runs, sags, peeling, or other defects. An enclosure marked Type 1 shall be acceptable if there is no visible rust at the conclusion of a salt spray (fog) test using the test method in ASTM B 117, employing a 5 percent by weight, salt solution for 24 hours.

### 2.4 TESTING

#### 2.4.1 Factory Testing

A prototype of specified ATS shall be factory tested in accordance with UL 1008. In addition, factory tests shall be performed on each ATS as follows:

- a. Insulation resistance test to ensure integrity and continuity of entire system.
- b. Main switch contact resistance test.
- c. Visual inspection to verify that each ATS is as specified.
- d. Mechanical test to verify that ATS sections are free of mechanical hindrances.
- e. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

#### 2.4.2 Factory Test Reports

Manufacturer shall provide three certified copies of factory test reports.

## PART 3 EXECUTION

### 3.1 INSTALLATION

ATS shall be installed as shown and in accordance with approved manufacturer's instructions.



### 3.2 INSTRUCTIONS

Manufacturer's approved operating instructions shall be permanently secured to cabinet where operator can see them. One-line and elementary or schematic diagram shall be permanently secured to inside of front enclosure door.

### 3.3 SITE TESTING

Following completion of ATS installation and after making proper adjustments and settings, site tests shall be performed in accordance with manufacturer's written instructions to demonstrate that each ATS functions satisfactorily and as specified. Contractor shall advise Contracting Officer not less than 5 working days prior to scheduled date for site testing, and shall provide certified field test reports within 2 calendar weeks following successful completion of site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:

- a. Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.
- b. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
- c. Low phase-to-ground voltage shall be simulated for each phase of normal source.
- d. Operation and settings shall be verified for specified ATS features, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
- e. Manual and automatic ATS and BP/IS functions shall be verified.

-- End of Section --

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## SECTION 16415A

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## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.10	(2004) Physical Aspects of Watthour Meters - Safety Standard
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C78.1	(1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.1375	(1996) 400-Watt, M59 Single-Ended Metal-Halide Lamps
ANSI C78.1376	(1996) 1000-Watt, M47 Metal-Halide Lamps
ANSI C78.20	(2003) Electric Lamps - Characteristics of Incandescent Lamps A, G, PS, and Similar Shapes with E26 Medium Screw Bases
ANSI C78.21	(2003) Electric Lamps - PAR and R Shapes
ANSI C78.2A	(1991) 18 & 26- Watt, Compact Fluorescent Quad Tube Lamps
ANSI C78.2B	(1992) 9 & 13-Watt, Compact Fluorescent Quad Tube Lamps **
ANSI C82.1	(1997) Specifications for Fluorescent Lamp Ballasts \ \$18.00\$ \ F \ X Addenda D & E
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(2001) Hard-Drawn Copper Wire
ASTM B 8	(2004) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(2001) Laminated Thermosetting Materials

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(1993) Instrument Transformers
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) \ \$31.00\$ \ F

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(2002) Molded Case Circuit Breakers and Molded Case Switches and Circuit Breaker Enclosures
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000) Industrial Control and Systems
NEMA ICS 2	(1996) Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993; R 2000) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems, Enclosures
NEMA LE 4	(2001) Recessed Luminaires, Ceiling Compatibility
NEMA MG 1	(2003) Motors and Generators
NEMA MG 10	(2001) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(2003) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(2000) Panelboards
NEMA RN 1	(1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA ST 20	(1992; R 1997) Dry-Type Transformers for General Applications
NEMA TC 13	(2000) Electrical Nonmetallic Tubing (ENT)
NEMA TC 2	(2003) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA VE 1	(2002) Metal Cable Tray Systems
NEMA WD 1	(1999) General Requirements for Wiring Devices
NEMA WD 6	(2002) Wiring Devices - Dimensional Requirements

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2003) Life Safety Code
NFPA 70	(2002) National Electrical Code

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

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## UNDERWRITERS LABORATORIES (UL)

UL 1	(2000) Flexible Metal Conduit
UL 1004	(1994; Rev thru Nov 1999) Electric Motors
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1242	(2000) Intermediate Metal Conduit
UL 1449	(1996; Rev thru Dec 1999) Transient Voltage Surge Suppressors
UL 1572	(1995; Rev thru Nov 1999) High Intensity Discharge Lighting Fixtures
UL 1598	(2003) Safety for Luminaires
UL 1660	(2004) Liquid-Tight Flexible Nonmetallic Conduit
UL 198B	(1995) Class H Fuses
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses



UL 198G	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 198L	(1995; Rev May 1995) D-C Fuses for Industrial Use
UL 20	(2000) General-Use Snap Switches
UL 360	(2003) Liquid-Tight Flexible Steel Conduit
UL 4	(2004) Armored Cable
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(2003) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(2000) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(2002) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 5	(2004) Surface Metal Raceways and Fittings
UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment
UL 506	(2000) Specialty Transformers
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; Rev thru Mar 1999) Fuseholders
UL 514A	(2004) Metallic Outlet Boxes
UL 514B	(2004) Fittings for Cable and Conduit
UL 542	(1999) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 6	(2004) Electrical Rigid Metal Conduit - Steel
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit

UL 651A	(2000) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 67	(1993; Rev thru Oct 1999) Panelboards
UL 719	(2002) Nonmetallic-Sheathed Cables
UL 797	(2004) Electrical Metallic Tubing
UL 817	(2001) Cord Sets and Power-
UL 83	(2003) Thermoplastic-Insulated Wires and Cables
UL 845	(1995; Rev thru Nov 1999) Motor Control Centers
UL 854	(1999) Service-Entrance Cables
UL 869A	(1998) Reference Standard for Service Equipment
UL 877	(1993; Rev thru Nov 1999) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 98	(2004) Enclosed and Dead-Front Switches
UL Elec Const Dir	(2004) Electrical Construction Equipment Directory

## 1.2 GENERAL

### 1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

### 1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible.

Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware

and structural support, even if not shown on the drawings.

### 1.2.3 Special Environments

#### 1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

#### 1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.2.5 Nameplates

#### 1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch  
High Letters

Minimum 1/8 inch  
High Letters

Panelboards  
Starters  
Safety Switches  
Transformers  
Equipment Enclosures  
Switchboards  
Motors

Control Power Transformers  
Control Devices  
Instrument Transformers

Each panel, section, or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

### 1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Interior Electrical Equipment; G, RE

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission.

Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.
- b. Grounding resistors.
- c. Motors and rotating machinery.
- d. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.
- e. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic

forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

#### SD-03 Product Data

Fault Current and Protective Device Coordination Study; G, AE

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures

Installation procedures for rotating equipment, transformers, switchgear, and battery systems. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

### As-Built Drawings

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

### Onsite Tests

A detailed description of the Contractor's proposed procedures for on-site tests.

### SD-06 Test Reports

#### Factory Test Reports

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

#### Field Test Plan

A detailed description of the Contractor's proposed procedures for onsite test submitted 20 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment

required, and tolerance limits.

#### Field Test Reports

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

#### SD-07 Certificates

##### Materials and Equipment

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

#### 1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

## 1.5 INTERIOR ELECTRICAL EQUIPMENT

Provide interior electrical equipment drawings.

## 1.6 Fault Current Study

Provide fault current and protective device coordination study.

## 1.7 Manufacturer's Catalog

Provide manufacturer's catalog for all electrical devices.

## 1.8 Material, Equipment, and Fixture Lists

Provide material, equipment, and fixture lists to the Contracting Officer.

## 1.9 Installation Procedures

Provide manufacturer's installation procedures for equipment specified in the "SUBMITTALS" paragraph in this section.

## 1.10 Factory Test Reports

Provide factory test reports as specified in SUBMITTALS paragraph in this section.

## 1.11 Field Test Plan

Submit field test plan to Contracting Officer.

# PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

## 2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

### 2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

### 2.1.2 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83, except that grounding wire may be type TW conforming to UL 83;



remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

#### 2.1.3 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

#### 2.1.4 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

#### 2.1.5 Non-metallic Sheathed Cable

UL 719, type NM or NMC.

#### 2.1.6 Armored Cable

UL 4; NFPA 70, Type AC cable.

#### 2.1.7 Cord Sets and Power-Supply Cords

UL 817.

### 2.2 CABLE TRAYS

Cable tray shall conform to NEMA VE 1, shall form a wireway system, and shall be of nominal 3 inch depth. Cable trays shall be constructed of zinc-coated steel. Trays shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius. Radius of bends shall be 12 inches.

#### 2.2.1 Solid Bottom

Solid bottom-type cable trays shall be of a nominal 12 inch width. Solid covers shall be provided. Solid covers shall be provided for red and yellow system cable trays. Solid covers shall be hinged, lockable with padlocks, with a maximum door segment size of 2 feet. Cable trays for red system shall be factory painted red and for black system, factory painted black and painted yellow for yellow system.

### 2.3 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be as indicated below:

- a. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
  - 1) LED indicator lights for power and protection status.
  - 2) Audible alarm, with silencing switch, to indicate when protection has failed.

- 3) Fuses, rated at 200-kA interrupting capacity.
- 4) Surge-event operations counter.
- 5) Remote annunciation.

Surge Current Capacity: The minimum total surge current that the device is capable of withstanding shall meet or exceed the following performance criteria:

- 1) Service Entrance: The TVSS shall provide a minimum protection of 240 kA per phase.
  - 2) Building Distribution Panels: The TVSS shall provide a minimum protection of 180 kA per phase.
  - 3) Branch Panels: The TVSS shall provide a minimum protection of 120 kA per phase.
- b. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:
- 1) Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
  - 2) Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
  - 3) Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

## 2.4 CIRCUIT BREAKERS

### 2.4.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, or enclosures.

#### 2.4.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

#### 2.4.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with

NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

#### 2.4.1.3 Cascade System Ratings

Circuit breakers used in series combinations is not allowed.

#### 2.4.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 225 amperes.

#### 2.4.2 Solid-State Trip Elements

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be torodial construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

- a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.
- b. Adjustable long-time delay.
- c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- d. Adjustable short-time delay.
- e. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

#### 2.4.3 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

#### 2.4.4 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

#### 2.4.5 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

### 2.5 CONDUIT AND TUBING

#### 2.5.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

#### 2.5.2 Electrical Nonmetallic Tubing (ENT)

NEMA TC 13.

#### 2.5.3 Electrical Plastic Tubing and Conduit

NEMA TC 2.

#### 2.5.4 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

#### 2.5.5 Intermediate Metal Conduit

UL 1242.

#### 2.5.6 PVC Coated Rigid Steel Conduit

NEMA RN 1.

#### 2.5.7 Rigid Metal Conduit

UL 6.

#### 2.5.8 Rigid Plastic Conduit

NEMA TC 2, UL 651 and UL 651A.

#### 2.5.9 Surface Metal Electrical Raceways and Fittings

UL 5.

### 2.6 CONDUIT AND DEVICE BOXES AND FITTINGS

#### 2.6.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

#### 2.6.2 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

#### 2.6.3 Fittings for Conduit and Outlet Boxes

UL 514B.

#### 2.6.4 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

#### 2.7 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

#### 2.8 CONNECTORS, WIRE PRESSURE

##### 2.8.1 For Use With Copper Conductors

UL 486A.

#### 2.9 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

##### 2.9.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

##### 2.9.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

#### 2.10 ENCLOSURES

NEMA ICS 6 unless otherwise specified.

##### 2.10.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

##### 2.10.2 Circuit Breaker Enclosures

UL 489.

#### 2.11 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below.

##### 2.11.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

- a. Incandescent and tungsten halogen lamps shall be designed for 125 volt operation (except for low voltage lamps), shall be rated for minimum life of 2,000 hours, and shall have color temperature between 2,800 and 3,200 degrees Kelvin. Tungsten halogen lamps shall incorporate quartz capsule construction. Lamps shall comply with ANSI C78.20 and sections 238 and 270 of ANSI C78.21.
- b. Fluorescent lamps shall be green-tipped and shall have color temperature as shown degrees Kelvin. They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens
T8, 59 watts	(8' lamp)	5700 lumens

(1) Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 82. Lamps of other lengths or types shall be used only where specified or shown. Lamps shall deliver rated life when operated on rapid start ballasts.

(2) Small compact fluorescent lamps shall be twin, double, or triple tube configuration as shown with bi-pin or four-pin snap-in base and shall have minimum CRI of 85. They shall deliver rated life when operated on ballasts as shown. 9 and 13 watt double tube lamps shall comply with ANSI C78.2B. 18 and 26 watt double tube lamps shall comply with ANSI C78.2A. Minimum starting temperature shall be 32 degrees F for twin tube lamps and for double and triple twin tube lamps without internal starter; and 15 degrees F for double and triple twin tube lamps with internal starter.

(3) Long compact fluorescent lamps shall be 18, 27, 39, 40, 50, or 55 watt bi-axial type as shown with four-pin snap-in base; shall have minimum CRI of 85; and shall have a minimum starting temperature of 50 degrees F. They shall deliver rated life when operated on rapid start ballasts.

- c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1375, and ANSI C78.1376.

## 2.11.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

- a. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless otherwise shown. Ballasts shall have maximum current crest factor of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture.

(1) Compact fluorescent ballasts shall comply with IEEE C62.41 Category A transient voltage variation requirements and shall be mounted integrally within compact fluorescent fixture housing unless otherwise shown. Ballasts shall have minimum ballast factor of 0.95; maximum current crest factor of 1.6; high power factor; maximum operating case temperature of 77 degrees F above ambient; shall be rated Class P; and shall have a sound rating of Class A. Ballasts shall meet FCC Class A specifications for EMI/RFI emissions. Ballasts shall operate from nominal line voltage of 277 volts at 60 Hz and maintain constant light output over a line voltage variation of  $\pm 10\%$ . Ballasts shall have an end-of-lamp-life detection and shut-down circuit. Ballasts shall be UL listed and shall contain no PCBs. Ballasts shall contain potting to secure PC board, provide lead strain relief, and provide a moisture barrier.

(2) Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 0 degrees F when used on exterior of the building. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum \$10 labor allowance per ballast.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid	120 or 277 V	1	2.54
	start		2	1.44
	linear		3	0.93

\* For ballasts not specifically designed for use with dimming controls.

(3) Dimming fluorescent ballasts shall be electronic and shall

comply with the applicable electronic ballast specifications shown above. Dimming ballasts shall be compatible with the specified dimming control equipment and shall operate the lamps shown in the range from full rated light output to 10 percent of full rated light output. Dimming ballasts shall provide smooth square law dimming such that perceived dimming action is proportionate to the motion of the dimming control. Single or two-lamp dimming ballasts shall be used. Multi-lamp dimming ballasts shall be designed to operate lamps of the same length and current rating.

(4) Dimming compact fluorescent ballasts shall be electronic and shall comply with the applicable compact fluorescent and dimming ballast specifications shown above. Ballasts shall operate the lamps shown in the range from full rated light output to 5 percent of full rated light output. Ballast power factor shall be <90% throughout dimming range. THD shall be <10% at maximum light output and <20% at minimum light output. Ballast shall ignite the lamps at any light output setting selected.

- c. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(1) Electronic high intensity discharge ballasts shall be constant wattage autotransformer type; shall have less than 10% ballast loss; shall have total harmonic distortion between 10 and 20%; and shall have a minimum starting temperature of 0 degrees F.

### 2.11.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Recessed housings shall be minimum 20 gauge cold rolled or galvanized steel as shown. Extruded aluminum fixtures shall have minimum wall thickness of 0.125 inches. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type. Conoid recessed reflector cones shall be Alzak with clear specular low iridescent finish.

- a. Fluorescent fixtures shall comply with UL 1598. Recessed ceiling fixtures shall comply with NEMA LE 4. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Fluorescent fixture lens frames on recessed and surface mounted troffers shall be one assembly with mitered corners. Parabolic louvers shall have a low iridescent finish and 45 degree cut-off. Louver intersection joints shall be hairline type and shall conceal mounting tabs or other assembly methods. Louvers shall be free from blemishes, lines or defects which distort the visual surface. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be constructed to include grounding necessary to start the lamps. Open fixtures shall be equipped with a sleeve, wire guard, or other positive means to prevent lamps from falling. Medium



bi-pin lampholders shall be twist-in type with positive locking position. Long compact fluorescent fixtures shall have clamps or secondary lampholders to support the free ends of the lamps.

- b. High intensity discharge fixture shall comply with UL 1572. Recessed ceiling fixtures shall comply with NEMA LE 4. Reflectors shall be anodized aluminum. Fixtures for horizontal lamps shall have position oriented lampholders. Lampholders shall be pulse-rated to 5,000 volts. Recessed lens fixtures shall have extruded aluminum lens frames. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Remote ballasts shall be encased and potted. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.
- c. Emergency lighting fixtures and accessories shall be constructed and independently tested to meet the requirements of applicable codes. Batteries shall be Nicad or equal with no required maintenance, and shall have a minimum life expectancy of five years and warranty period of three years.
- d. Exit Signs

Exit signs shall be ENERGY STAR compliant, thereby meeting the following requirements. Input power shall be less than 5 watts per face. Letter size and spacing shall adhere to NFPA 101. Luminance contrast shall be greater than 0.8. Average luminance shall be greater than 15 cd/m<sup>2</sup> measured at normal (0 degree) and 45 degree viewing angles. Minimum luminance shall be greater than 8.6 cd/m<sup>2</sup> measured at normal and 45 degree viewing angles. Maximum to minimum luminance shall be less than 20:1 measured at normal and 45 degree viewing angles. The manufacturer warranty for defective parts shall be at least 5 years.

#### 2.11.4 Lampholders, Starters, and Starter Holders

UL 542

#### 2.12 LOW-VOLTAGE FUSES AND FUSEHOLDERS

##### 2.12.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

##### 2.12.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

##### 2.12.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

##### 2.12.4 Fuses, Class H

UL 198B.

##### 2.12.5 Fuses, Class R

UL 198E.

## 2.12.6 Fuses, Class T

UL 198H.

## 2.12.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

## 2.12.8 Fuses, D-C for Industrial Use

UL 198L.

## 2.12.9 Fuseholders

UL 512.

## 2.13 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

## 2.14 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

## 2.14.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

## 2.14.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES  
OPEN DRIP PROOF MOTORS

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5

3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

## TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

## 2.15 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

## 2.15.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.  
Panelboards supplying non-linear loads shall have neutrals sized for 200

percent of rated current.

## 2.15.2 Motor Starters

Combination starters shall be provided as indicated.

### 2.15.2.1 Reduced-Voltage Starters

Reduced-voltage starters shall be provided for polyphase motors 20 hp or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors.

### 2.15.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

### 2.15.4 Low-Voltage Motor Overload Relays

#### 2.15.4.1 General

Thermal and magnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds.

#### 2.15.4.2 Construction

Manual reset type thermal relay shall be bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

#### 2.15.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

## 2.15.5 Automatic Control Devices

### 2.15.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

### 2.15.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

### 2.15.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.
- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

## 2.16 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67. Panelboards shall consist of assemblies of molded-case circuit breakers with buses and terminal lugs for the control and protection of branch circuits to motors, heating devices and other equipment operating at 480 volts ac or less. Panelboards shall be UL 67 labeled. "Loadcenter" type panels are not acceptable. panelboards shall be designed for installation in surface-mounted or flush-mounted cabinets accessible from the front only, as shown on the drawings. Panelboards shall be fully rated for a short-circuit current as indicated on panelboard schedules; refer to Plans.

### 2.16.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gage if flush-mounted or mounted outdoors, and not less than No. 12 gage if surface-mounted indoors, with full seam-welded box ends. Cabinets mounted outdoors or flush-mounted shall be hot-dipped galvanized after fabrication. Cabinets shall be painted in accordance with paragraph PAINTING. Front edges of

cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets. Enclosure shall have nameplates. Directory holders, containing a neatly typed directory under a transparent cover, shall be provided on the inside of panelboard doors.

#### 2.16.2 Buses

All panelboards shall be of the dead-front type with buses and circuit breakers mounted on a plate or base for installation as a unit in a cabinet. The sizes of buses and the details of panelboard construction shall meet or exceed the requirements of NEMA PB 1.

#### 2.16.3 Components

Each branch circuit, and the main buses where so specified or shown on the drawings, shall be equipped with molded-case circuit breakers having overcurrent trip ratings as shown on the drawings. The circuit breakers shall be of a type designed for bolted connection to buses in a panelboard assembly, and shall meet the requirements of Section 16415A, ELECTRICAL WORK, INTERIOR, paragraph MOLDED CASE CIRCUIT BREAKERS. Circuit breakers of the same frame size and rating shall be interchangeable.

#### 2.17 RECEPTACLES

##### 2.17.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

##### 2.17.2 Ground Fault Interrupters

UL 943, Class A or B.

##### 2.17.3 NEMA Standard Receptacle Configurations

NEMA WD 6.

- a. Single and Duplex, 20-Ampere, 125 Volt

20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

- b. 15-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-15R, locking: NEMA type L6-15R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-15R, locking: NEMA type L15-15R.

- c. 20-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-20R, locking: NEMA

type L6-20R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-20R, locking: NEMA type L15-20R.

d. 30-Ampere, 125/250 Volt

Three-pole, 3-wire, non-locking: NEMA type 10-30R, locking: NEMA type L10-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 14-30R, locking: NEMA type L14-30R.

e. 30-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-30R, locking: NEMA type L6-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-30R, locking: NEMA type L15-30R.

f. 50-Ampere, 125/250 Volt

Three-pole, 3-wire: NEMA type 10-50R. Three-pole, 4-wire grounding: NEMA type 14-50R.

g. 50-Ampere, 250 Volt

Two-pole, 3-wire grounding: NEMA type 6-50R. Three-pole, 4-wire grounding: NEMA type 15-50R.

2.18 Service Entrance Equipment

UL 869A.

2.19 SPLICE, CONDUCTOR

UL 486C.

2.20 SNAP SWITCHES

UL 20.

2.21 TAPES

2.21.1 Plastic Tape

UL 510.

2.21.2 Rubber Tape

UL 510.

2.22 TRANSFORMERS

Three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below. Transformers supplying non-linear loads shall be UL listed as suitable for supplying such loads with a total K-factor not to exceed K-4 and have neutrals sized for 200 percent of rated current.

### 2.22.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

#### a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Transformers shall be provided in NEMA 1 enclosure. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

### 2.22.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55

### 2.23 WATTHOUR/DEMAND METERS, CHECK

ANSI C12.10 for self-contained watthour-demand meter with pulse-initiators for remote monitoring of watt-hour usage and instantaneous demand. Meter shall be socket-mounted indoor type. Meter shall be Class 10.

### 2.24 INSTRUMENT TRANSFORMERS

#### 2.24.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

#### 2.24.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than 2.0. Other thermal and mechanical ratings of current transformer and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the



associated instrument and relay cabinets.

#### 2.24.2.1 Current Transformers for kWH and Demand Metering (Low Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a metering accuracy Class with a minimum RF at 30 degrees C, with 600-volt insulation, and 10 kV BIL as indicated on Drawings. Provide butyl-molded, window-type current transformers mounted in the current transformer cabinet.

#### 2.25 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

#### 2.26 FLOOR BOX

Construction: Boxes shall consist of a concrete-tight stamped steel construction with 14 gauge sides and bottom and a 10 gauge steel top.

##### 2.26.1 Dimensions

The approximate box exterior dimensions are to be as indicated on plans.

##### 2.26.2 Knockouts

Access to each end of the floor box shall be provided by concentric 1 inch and 1 1/4 inch knockouts. Access from behind and below each multi-gang compartment shall be provided by concentric 1 inch and 1-1/4 inch knockouts. Access from behind and below each single gang compartment shall be provided by concentric 3/4 inch and 1 inch, or 1 inch and 1 1/4 inch knockouts.

##### 2.26.3 Adjustment

External pre-pour adjustment shall be provided by at least 2 inch leveling screws.

##### 2.26.4 Cover

Cover shall be cast aluminum. Lid to be offered with an insertion option for carpet or tile inlay. Egress to be provided by two 15/16 inches by 6 3/8 inches access doors. Access door is to fold under lid during cable exit for unobtrusive appearance and mechanical protection.

- a. Load Capacity: Activation covers shall maintain 3000 lbs loading.

### PART 3 EXECUTION

#### 3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

##### 3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 5 ohms under normally dry conditions. If this resistance

cannot be obtained with a single rod, install additional rods not less than 6 feet on centers, to achieve 5 ohms under normally dry conditions. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 5 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. For raised floor equipment rooms in computer and data processing centers, a minimum of 4, one at each corner, multiple grounding systems shall be furnished. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

### 3.1.3 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

## 3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid plastic conduit, electrical metallic tubing, electrical nonmetallic tubing, and intermediate metal conduit. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

### 3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in

damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07840 FIRESTOPPING. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

#### 3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

#### 3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

#### 3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

#### 3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness

shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

#### 3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

#### 3.2.1.6 Supports

Metallic conduits and tubing, and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

#### 3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

### 3.2.1.8 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

### 3.2.1.9 Communications Raceways

- a. Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.
- b. Conduit for red, black, and yellow systems shall be color-coded with phasing tape at 10-foot intervals and within 6 inches of each connector.
- c. Conduits for the black system shall be separated a minimum of 2 inches from all water pipes, ductwork, power or other metal conduits.
- d. Conduits for the red system shall be separated a minimum of 6 inches from all black system, yellow system, power, controls, cable television, security, card access, fire alarm, mass notification system raceways and/or devices, etc.
- e. Conduits for the yellow system shall be separated a minimum of 6 inches from all black system, red system, power, controls, cable television, security, card access, fire alarm, mass notification system raceways and/or devices, etc.
- f. There shall be no interconnection between black, red, and yellow systems. Color-code conduits as shown on communications drawings.

### 3.2.2 Cable Trays

Do not terminate conduits in top or bottom of cable trays. Maintain a 1-foot clearance above all cable trays and a 2-foot clearance on a minimum of one side of cable tray to allow for cable installation and changes.

### 3.2.3 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

#### 3.2.3.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller

than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

### 3.2.3.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used.

### 3.2.3.3 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).

277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

## 3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total

combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

Boxes for black, red, and yellow communications shall not be ganged and shall be separated by at least 6 inches for adjacent black, red, yellow communications devices and power devices.

### 3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA rated as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

### 3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

### 3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with

suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

#### 3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

#### 3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be ivory. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

#### 3.5 RECEPTACLES

##### 3.5.1 Single and Duplex, 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

##### 3.5.2 Floor Outlets

Floor outlets shall be adjustable and each outlet shall consist of a



cast-metal body with threaded openings for conduits, adjustable ring, and cover plate with 1/2 inch or 3/4 inch threaded flush plug. Each telephone outlet shall consist of a horizontal cast housing with a receptacle as specified. Gaskets shall be used where necessary to ensure a watertight installation. Plugs with installation instructions shall be delivered to the Contracting Officer at the job site for capping outlets upon removal of service fittings.

### 3.5.3 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

#### 3.5.3.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

#### 3.5.3.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use.

#### 3.5.4 Receptacles, 15-Ampere, 250-Volt

Receptacles, 15-ampere, 250-volt, shall be single two-pole, three-wire, grounding type with bodies of ivory phenolic compound supported by mounting yoke having plaster ears. The third grounding pole shall be connected to the metal yoke. Each receptacle shall be provided with a mating cord-grip plug.

#### 3.5.5 Receptacles, 20-Ampere, 250-Volt

Receptacles, single, 20-ampere, 250-volt, shall be ivory molded plastic, two-pole, three-wire or three-pole, four-wire, grounding type complete with appropriate mating cord-grip plug.

#### 3.5.6 Receptacles, 30-Ampere, 125/250-Volt

Receptacles, single, 30-ampere, 125/250-volt, shall be molded-plastic, three-pole, four-wire, grounding type, complete with appropriate mating cord-grip type attachment plug. Each dryer receptacle shall be furnished with a non-detachable power supply cord for connection to the electric clothes dryer. The cord shall be an angle-type 36 inch length of Type SRD range and dryer cable with three No. 10 AWG conductors.

### 3.5.7 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

### 3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 120/277-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

### 3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the type indicated with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

### 3.8 PANELBOARDS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

#### 3.8.1 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

### 3.9 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

### 3.9.1 Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

### 3.9.2 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK1, RK5 shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

### 3.9.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

## 3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits and exterior communications conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

## 3.11 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

## 3.12 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be

mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

#### 3.12.1 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

#### 3.12.2 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

#### 3.13 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

#### 3.14 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye. Transformers to be located within the building may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40

degrees C ambient temperature, unless otherwise indicated.

### 3.15 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

#### 3.15.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

#### 3.15.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on the drawings. Illustrations shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

##### 3.15.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

##### 3.15.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

##### 3.15.2.3 Fixtures for Installation in Grid Type Ceilings

Fixtures for installation in grid type ceilings which are smaller than a full tile shall be centered in the tile. 1 by 4 foot fixtures shall be mounted along the grid rail as shown. Work above the ceiling shall be coordinated among the trades to provide the lighting layout shown. Fixtures mounted to the grid shall have trim exactly compatible with the grid. Contractor shall coordinate trims with ceiling trades prior to ordering fixtures. Metric fixtures shall be designed to fit the metric grid specified. Fixtures in continuous rows shall be coordinated between

trades prior to ordering. Fixtures shall be mounted using independent supports capable of supporting the entire weight of the fixture. No fixture shall rest solely on the ceiling grid. Recessed fixtures installed in seismic areas should be installed utilizing specially designed seismic clips. Junction boxes shall be supported at four points.

#### 3.15.2.4 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers or hand-straightens so that they hang plumb. Pendants, rods, chains, or cables 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degrees of separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

#### 3.15.3 Ballasts

Remote type ballasts or transformers, where indicated, shall be mounted in a well ventilated, easily accessible location, within the maximum operating distance from the lamp as designated by the manufacturer.

#### 3.16 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

Install devices at service entrance on load side, with ground lead bonded to service entrance ground. Install devices for panelboard with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

#### 3.17 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

##### 3.17.1 Motors and Motor Control

Motors and motor controls shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

### 3.17.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

### 3.18 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

The minimum concrete pour depth shall be 4 1/8 inches. The floor box shall contain four leveling legs to provide full pre-concrete pour adjustment. Additionally, the box shall ship with a disposable cover to prevent the entry of debris during the construction phase. The floor box shall be warranted for one year from the date of final acceptance.

### 3.19 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTS AND COATINGS.

### 3.20 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

#### 3.20.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.20.2 Ground-Resistance Tests

The resistance of each grounding electrode system and ground grid shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Grid electrode - 5 ohms.

### 3.20.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 48 hours before the site is ready for inspection.

### 3.20.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

#### 3.20.4.1 Medium Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.
- c. DC high-potential test.

#### 3.20.4.2 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

### 3.20.5 Motor Tests

- a. Phase rotation test to ensure proper directions.

## 3.21 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

## 3.22 FIELD SERVICE

### 3.22.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 40 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating,



starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS or format video tape of the entire training shall be submitted.

#### 3.22.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

#### 3.23 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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05/01

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## SECTION 16528A

## EXTERIOR LIGHTING

05/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO LTS-4 (2001; 2002 Interim; R 2003) Standard  
Specifications for Structural Supports for  
Highway Signs, Luminaires and Traffic  
Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.1 (1991; C78.1a; R 1996) Fluorescent Lamps -  
Rapid-Start Types - Dimensional and  
Electrical Characteristics

ANSI C78.1375 (1996) 400-Watt, M59 Single-Ended  
Metal-Halide Lamps

ANSI C78.1376 (1996) 1000-Watt, M47 Metal-Halide Lamps

ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated

ANSI C82.4 (1992) Ballasts for  
High-Intensity-Discharge and Low-Pressure  
Sodium Lamps (Multiple-Supply Type)

ANSI C119.1 (2002) Sealed Insulated Underground  
Connector Systems Rated 600 Volts

ANSI C136.2 (1996) Luminaire Voltage Classification  
for Roadway and Area Lighting Equipment

ANSI C136.3 (2004) Roadway Lighting  
Equipment-Luminaire Attachments

ANSI C136.6 (1997) Roadway Lighting Equipment - Metal  
Heads and Reflector Assemblies -  
Mechanical and Optical Interchangeability

ANSI C136.9 (2003) Roadway Lighting - Socket Support  
Assemblies for Use in Metal Heads -  
Mechanical Interchangeability

ANSI C136.11 (1995) Multiple Sockets for Roadway

## Lighting Equipment

ANSI C136.15 (1997) Roadway Lighting, High Intensity Discharge and Low Pressure Sodium Lamps in Luminaires -

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (2004) Carbon Structural Steel

ASTM A 123/A 123M (2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM B 117 (2003) Operating Salt Spray (Fog) Apparatus

ASTM D 1654 (1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

## ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA RP-8 (2000) Roadway Lighting

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE C136.13 (1999) Metal Brackets for Wood Poles

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (2000) Industrial Control and Systems

NEMA ICS 2 (1996) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 6 (1993; R 2001) Industrial Control and Systems, Enclosures

NEMA OS 1 (2003) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA OS 2 (2003) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

NEMA RN 1 (1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and

## Intermediate Metal Conduit

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 6	(2004) Electrical Rigid Metal Conduit - Steel
UL 44	(1999) Thermoset-Insulated Wires and Cables
UL 98	(2004) Enclosed and Dead-Front Switches
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(2003) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 514A	(2004) Metallic Outlet Boxes
UL 514B	(2004) Conduit, Tubing and Cable Fittings
UL 514C	(1996; Rev thru Dec 1999) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 854	(1999) Service-Entrance Cables
UL 886	(1994; Rev thru Apr 1999) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1598	(2003) Safety for Luminaires

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Lighting System; G, RE  
Detail Drawings; G, RE

Detail drawings for the complete system and for poles, lighting fixtures, and bracket arms.

### As-Built Drawings

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

## SD-03 Product Data

### Equipment and Materials

Data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is otherwise suitable for the application and fully conforms to the requirements specified.

### Operating Test

Test procedures and reports for the Operating Test. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. The final test procedures report shall be delivered after completion of the tests.

### Ground Resistance Measurements

The measured resistance to ground of each separate grounding installation, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made. The information shall be in writing.

## SD-10 Operation and Maintenance Data

### Lighting System

A draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. The draft copy used during site testing shall be updated with any changes required, prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the field test shall include modifications made during installation checkout and acceptance.

## 1.3 SYSTEM DESCRIPTION

### 1.3.1 Lighting System

The lighting system shall be configured as specified and shown. The system shall include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

### 1.3.2 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

### 1.3.3 Standard Products

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

## 1.4 CORROSION PROTECTION

### 1.4.1 Aluminum Materials

Aluminum shall not be used.

### 1.4.2 Ferrous Metal Materials

#### 1.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 1.4.2.2 Equipment

Equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall have a rating of not less than 7 in accordance with TABLE 1, (procedure A) of ASTM D 1654. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 1.4.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in Section 09900 PAINTING, GENERAL.

## 1.5 Detail Drawings

Include in submittal complete point-to-point lighting calculations for the following zones:

- a. Submit calculation for the site parameter using fixture "W6".
- b. Submit calculation for hardstand area using fixture "W1".

## 1.6 Equipment and Materials

Submit published data to Contracting Officer as stated in "SUBMITTALS" paragraph in this section.



## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

### 2.2 BRACKET ARMS

#### 2.2.1 Steel Poles

Poles shall be provided with bracket arms of the support arm style and of the length indicated on drawings. Bracket arms shall conform to the design of the pole provided. The bracket arms shall be capable of supporting the equipment to be mounted on it with the maximum wind and ice loading encountered at the site. Strength of bracket arms shall be in accordance with IEEE C136.13. Steel brackets shall be galvanized. Wood bracket arms shall not be used.

#### 2.2.2 Floodlight Brackets

Floodlight brackets shall be coordinated with the floodlight support provided.

### 2.3 CABLE

The Contractor shall provide all wire and cable not indicated as government furnished equipment. Wire and cable components shall be able to withstand the jobsite environment for a minimum of 20 years.

#### 2.3.1 Insulated Cable

Cable shall be type USE conforming to UL 854, with copper conductors and type RHW or XHHW insulation conforming to UL 44, and shall include green ground conductor. Cable shall be provided with insulation of a thickness not less than that given in column A of TABLE 15.1 of UL 854. Cable shall be rated 600 volts. Parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded.

### 2.4 CABLE SPLICES AND CONNECTORS

Cable splices and connectors shall conform to UL 486A. Underground splices and connectors shall also conform to the requirements of ANSI C119.1.

### 2.5 CABLE BOXES

Boxes and covers shall be made of cast iron with zinc coated or aluminized finish. The minimum inside dimensions shall be not less than 12 inches square by 6 inches deep and not less than required to house the cable splice. A suitable gasket shall be installed between the box and cover for watertightness. A sufficient number of screws shall be installed to hold the cover in place along the entire surface of contact. Grounding lugs shall be provided.

## 2.6 CONDUIT, DUCTS AND FITTINGS

### 2.6.1 Conduit, Rigid Steel

Rigid steel conduit shall conform to ANSI C80.1 and UL 6.

### 2.6.2 Conduit Coatings

Underground metallic conduit and fittings shall be coated with a plastic resin system conforming to NEMA RN 1, Type 40. Epoxy systems may also be used.

### 2.6.3 Conduit Fittings and Outlets

#### 2.6.3.1 Boxes, Metallic Outlets

NEMA OS 1 and UL 514A.

#### 2.6.3.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

#### 2.6.3.3 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

#### 2.6.3.4 Boxes, Switch (Enclosed), Surface Mounted

UL 98.

#### 2.6.3.5 Fittings for Conduit and Outlet Boxes

UL 514B.

#### 2.6.3.6 Fittings for Use in Hazardous (Classified) Locations

UL 886.

#### 2.6.3.7 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

### 2.6.4 Non-Metallic Duct

Non-metallic duct lines and fittings utilized for underground installation shall be suitable for the application. Duct shall be thick-wall, single, round-bore type. Material of one type shall be used. Schedule 40 polyvinyl chloride (PVC) shall conform to UL 651. Plastic utility duct and fittings manufactured without a UL label or listing shall be provided with a certification as follows: "The materials are suitable for use with 167 degree F wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

## 2.7 GROUND RODS

Ground rods shall be of copper clad steel conforming to UL 467 not less than

3/4 inch in diameter by 10 feet in length of the sectional type driven full length into earth.

## 2.8 POLES

Metal and concrete poles shall be the pole manufacturer's standard design for supporting the number of fixtures indicated. Poles shall be designed for a wind velocity of 90 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-4. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. The type of pole shaft material provided shall not be mixed on any project. Grounding connection shall be provided near the bottom of each metal pole. Scratched, stained, chipped, or dented poles shall not be installed.

### 2.8.1 Steel Poles

Steel poles shall be hot-dip galvanized in accordance with ASTM A 123/A 123M and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor bolt-mounted type.

### 2.8.2 Anchor Bolts

Anchor bolts shall be the pole manufacturer's standard, but not less than necessary to meet the pole wind and ice loading, herein and other specified design requirements.

## 2.9 ILLUMINATION

### 2.9.1 General Lighting

Luminaires, ballasts, lamps, and control devices required for general area and hardstand lighting shall be in accordance with Standard Detail No. 40-06-04, shown on Plans.

## 2.10 LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

### 2.10.1 Metal-Halide

Lamps shall be made by a manufacturer with not less than 5 years experience in making metal-halide lamps. Metal-halide lamps shall conform to ANSI C78.1375 or ANSI C78.1376. Ballasts shall conform to ANSI C82.4 or UL 1029.

### 2.11 LAMPS, FLUORESCENT

Fluorescent lamps shall have standard cool-white color characteristics and shall not require starter switches. The lamps shall be of the rapid-start type.

### 2.12 LUMINAIRE COMPONENTS

Luminaire components shall conform to the following: attachments, ANSI C136.3; voltage classification, ANSI C136.2; field identification marking,

ANSI C136.15; interchangeability, ANSI C136.6 and ANSI C136.9; and sockets, ANSI C136.11.

## 2.13 LIGHTING CONTROL EQUIPMENT

### 2.13.1 Timer Control Switches

Astronomic dial type arranged to turn "ON" at sunset, and turn "OFF" at a pre-determined time as determined by User, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise shall be provided. A switch rated 120 volts, having battery backed electronic clock to maintain accurate time for a minimum of 7 hours following a power failure shall be provided. A time switch with a manual on-off bypass switch shall be provided. Housing for the time switch shall be a surface mounted, NEMA 1 (indoor) enclosure conforming to NEMA ICS 6.

### 2.13.2 Manual Control Switches

Manual control switches shall conform to UL 98. The switches shall be the heavy-duty type and shall be suitable for operation on a 120 volt, 60 Hz system. The number of poles and ampere rating shall be as indicated.

### 2.13.3 Magnetic Contactor

Magnetic contactors shall be mechanically held, electrically operated, and shall conform to NEMA ICS 1 and NEMA ICS 2. The contactor shall be suitable for 277 volts, single phase, 60 Hz. Coil voltage shall be 120 volts. Maximum continuous ampere rating and number of poles shall be as indicated on drawings. Enclosures for contactors mounted indoors shall be NEMA ICS 6, Type 1. Each contactor shall be provided with a spare, normally open auxiliary contact. Terminal lugs shall be coordinated with the wire size.

## 2.14 PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to IESNA RP-8.

## 2.15 LUMINAIRES, FLOODLIGHTING

### 2.15.1 HID

HID lighting fixtures shall conform to UL 1598.

### 2.15.2 Fluorescent

Fluorescent lamps shall conform to ANSI C78.1.

## 2.16 FIXTURES

Standard fixtures shall be as detailed on Standard Detail No. 40-06-04, Sheet Nos. E-47 through E-49 which accompany and form a part of this specification. Special fixtures shall be as indicated on the drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality will be acceptable as approved.

### 2.16.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

### 2.16.2 Special Fixtures

The types of special fixtures are designated by letters and numbers. For example, SP-1 denotes special Type 1.

## PART 3 EXECUTION

### 3.1 GENERAL

The Contractor shall install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2, and contract documents, and shall furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

#### 3.1.1 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government. The Contractor shall not take any corrective action without written permission from the Government.

### 3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

### 3.3 PREVENTION OF CORROSION

#### 3.3.1 Aluminum

Aluminum shall not be used in contact with earth or concrete, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

### 3.4 DUCT LINES

#### 3.4.1 Requirements

Numbers and size of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inches in diameter, and 36

inches for duct 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells when duct lines terminate in manholes or handholes.

#### 3.4.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and shall match factory tapers. A coupling recommended by the duct manufacturer shall be used when an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.4.3 Nonencased Direct-Burial

Top of duct lines shall be below the frost line, but not less than 48 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Where bottoms of trenches comprise materials other than sand, a 3-inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6-inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth.

#### 3.4.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved.

##### 3.4.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4 turn to set the joint tightly.

#### 3.4.5 Concrete

Concrete work shall be as specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete shall be plain, 2500 psi at 28 days, except that reinforced concrete shall be 3000 psi at 28 days.

#### 3.4.6 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other duct locations that are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than

3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

### 3.5 POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height as indicated on Plans. Pole installation shall conform to the manufacturer's recommendations, NFPA 70, and IEEE C2. Poles shall be set straight and plumb.

#### 3.5.1 Pole Brackets

Brackets shall be installed as specified by the manufacturer and as shown on drawings. Mounting hardware shall be sized appropriately to secure the mount, luminaire, and housing with wind and ice loading normally encountered at the site. Pole brackets for floodlights shall have the number of tenons indicated, arranged to provide the indicated spread between each tenon. Where indicated on drawings, adjustable heads shall be installed on the brackets to position the luminaires. Identical brackets shall be used with one type of luminaire.

#### 3.5.2 Concrete Foundations

Concrete foundations shall have anchor bolts accurately set in the foundation using a template supplied by the pole manufacturer. Once the concrete has cured, the pole shall be set on the foundation, leveled on the foundation bolts, and secured with the holding nuts. The space between the foundation and the pole base shall be grouted. Concrete and grout work shall conform to Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete shall be 3000 psi at 28 days.

#### 3.5.3 Steel Pole Installation

Poles shall be mounted on cast-in-place or power-installed screw foundations. Conduit elbows shall be provided for cable entrances into pole interiors.

##### 3.5.3.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufactures standard, and not less than necessary to meet the pole wind loading and other specified design requirements.

##### 3.5.3.2 Power-Installed Screw Foundations

Power-installed screw foundations having the required strength mounting bolt and top plate dimensions may be utilized. Screw foundations shall be of at least 1/4 inch thick structural steel conforming to ASTM A 36/A 36M and hot-dip galvanized in accordance with ASTM A 123/A 123M. Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be

approved before installation of any screw foundation.

### 3.6 LIGHTING

#### 3.6.1 Lamps

Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original containers and installed in the fixtures just before completion of the project.

#### 3.6.2 Fixture Installation

Standard fixtures shall be installed as detailed on Standard Detail No. 04-06-04, which accompany and form a part of this specification. Special fixtures shall be as indicated on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality will be acceptable as approved.

##### 3.6.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be installed as required for proper installation.

### 3.7 LIGHTING CONTROL SYSTEM

#### 3.7.1 Time Control Switches

Switches shall be installed with not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

#### 3.7.2 Magnetic Contactors

Terminal lugs shall be coordinated with the wire size. Switches shall be securely fastened to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

### 3.8 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following. Grounding conductors shall be soft-drawn, stranded copper. Ground rods shall be driven into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade, except in handholes.

#### 3.8.1 Ground Rods and Pole Butt Electrodes

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes shall be up to three, 10 feet long rods spaced a minimum of 10 feet apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below



grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.8.2 Items to be Grounded

Ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment shall be grounded. Connections above grade shall be made with solderless connectors, and those below grade shall be made by a fusion-welding process.

### 3.8.3 Lighting Pole

One ground rod shall be provided at each pole. Bases of metal or concrete lighting poles shall be connected to ground rods by means of No. 8 AWG bare copper wire.

## 3.9 TESTS

### 3.9.1 Operating Test

After the installation is completed and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements specified. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test, and the Government will furnish the necessary electric power.

### 3.9.2 Ground Resistance Measurements

The resistance to ground shall be measured by the fall-of-potential method described in IEEE Std 81.

The contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "as-built" drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the lighting system. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the as-built drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and shall complete the work as required.

-- End of Section --

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## SECTION 16710A

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09/02

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## SECTION 16710A

## PREMISES DISTRIBUTION SYSTEM

09/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/TIA/EIA-568-B	(2001) Commercial Building Telecommunications Cabling Standard
EIA ANSI/TIA/EIA-568-B.2-1	(2002) Transmission Performance Specifications for 4-pair 100 ohm Category 6 Cabling
EIA ANSI/TIA/EIA-569-A	(2001) Commercial Building Standard for Telecommunications Pathways and Spaces
EIA ANSI/TIA/EIA-606A	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA ANSI/TIA/EIA-607A	(1994) Commercial Building Grounding/Bonding Requirement Standard
EIA TIA/EIA-TSB-67	(1995) Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems

## IBM CORPORATION (IBM)

IBM GA27-3361-07	(1987) LAN Cabling System - Planning and Installation
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## INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(1994) Fiber Optic Premises Distribution Cable
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## U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-HDBK-419A	(29 Dec. 1987) Grounding, Bonding, and Shielding for Electronic Military Systems and Facilities
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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NFPA 70	(2002) National Electrical Code
NFPA 90A	(2002) Installation of Air Conditioning and Ventilating Systems
NFPA 262	(2002) Standard Method of Test for Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

## 1.2 SYSTEM DESCRIPTION

The premises distribution system shall consist of inside-plant horizontal, riser, and backbone cables and connecting hardware to transport telephone and data (including LAN) signals between equipment items in a building.

Three separate and isolated systems shall be provided. The three systems are:

- 1) Black System (unclassified)
- 2) Red System (classified)
- 3) Yellow System (classified)

All cabling, conduits, cable trays, boxes, racks, grounding, etc., shall be separate and isolated to each of the above system colors. No physical connection shall exist between the black, red or yellow systems.

## 1.3 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Premises Distribution System; G, RE

Detail drawings including a complete list of equipment and material. Detail drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack details, elevation drawings of telecommunications closet walls, outlet face plate details for all outlet configurations, sizes and types of all cables, conduits, and cable trays. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

#### Installation; G, RE

Record drawings for the installed wiring system infrastructure per EIA ANSI/TIA/EIA-606A. The drawings shall show the location of all cable terminations and location and routing of all backbone and horizontal cables. The identifier for each termination and cable shall appear on the drawings.

#### SD-03 Product Data

##### Record Keeping and Documentation; G, RE

Documentation on cables and termination hardware in accordance with EIA ANSI/TIA/EIA-606A.

##### Spare Parts; G, RE

Lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings, not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

##### Manufacturer's Recommendations; G, RE

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations, prior to installation shall be provided. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

##### Test Plan; G, RE

Test plan defining the tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to the proposed test date. The test plan must be approved before the start of any testing. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

##### Qualifications; G, RE

The qualifications of the Manufacturer, Contractor, and the Installer to perform the work specified herein. This shall include proof of the minimum qualifications specified herein.

#### SD-06 Test Reports

##### Test Reports; G, RE

Test reports in booklet form with witness signatures verifying execution of tests. Test results will also be provided on 3-1/2 inch diskettes in ASCII format. Reports shall show the field tests performed to verify compliance with the specified performance criteria. Test reports shall include record of the physical parameters verified during testing. Test reports shall

be submitted within 7 days after completion of testing.

#### SD-07 Certificates

Premises Distribution System; G, RE

Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-B.2-1, EIA ANSI/TIA/EIA-569-A, and EIA ANSI/TIA/EIA-606A standards.

Materials and Equipment; G, RE

Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

Installers; G, RE

The Contractor shall submit certification that all the installers are factory certified to install and test the provided products.

### 1.5 QUALIFICATIONS

#### 1.5.1 Minimum Contractor Qualifications

All work under this section shall be performed by and all equipment shall be furnished and installed by a certified Telecommunications Contractor, hereafter referred to as the Contractor. The Contractor shall have the following qualifications in Telecommunications Systems installation:

- a. Contractor shall have a minimum of 5 years experience in the application, installation and testing of the specified systems and equipment.
- b. All supervisors and installers assigned to the installation of this system or any of its components shall have factory certification from each equipment manufacturer that they are qualified to install and test the provided products.
- c. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components.

#### 1.5.2 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract will be from manufacturers that have a minimum of 5 years experience in producing the types of systems and equipment specified.

## 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust or other contaminants.

## 1.7 OPERATION AND MAINTENANCE MANUALS

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

## 1.8 RECORD KEEPING AND DOCUMENTATION

### 1.8.1 Cables

A record of all installed cable shall be provided in hard copy format per EIA ANSI/TIA/EIA-606A. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility per EIA ANSI/TIA/EIA-606A.

### 1.8.2 Termination Hardware

A record of all installed patch panels and outlets shall be provided in hard copy format per EIA ANSI/TIA/EIA-606A. The hardware records shall include only the required data fields per EIA ANSI/TIA/EIA-606A.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

### 2.2 UNSHIELDED TWISTED PAIR CABLE SYSTEM

#### 2.2.1 Backbone Cable

Backbone cable shall meet the requirements of EIA ANSI/TIA/EIA-568-B for Category 3 100-ohm unshielded twisted pair cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated CMR per NFPA 70.

#### 2.2.2 Connecting Hardware

Connecting and cross-connecting hardware shall be the same category as the cable it serves. Hardware shall be in accordance with EIA ANSI/TIA/EIA-568-B.

##### 2.2.2.1 Patch Panels

Patch panels shall consist of eight-position modular jacks, with rear



mounted type 110 insulation displacement connectors, arranged in rows or columns on 19 inch rack mounted or wall mounted panels as shown on Drawings. Jack pin/pair configuration shall be T568A per EIA ANSI/TIA/EIA-568-B. Jacks shall be unkeyed. Panels shall be provided with labeling space. The modular jacks shall conform to the requirements of EIA ANSI/TIA/EIA-568-B, and shall be rated for use with Category 6 cable in accordance with EIA ANSI/TIA/EIA-568-B.2-1 and shall meet the Link Test parameters as listed in EIA TIA/EIA-TSB-67 and supplemented by EIA ANSI/TIA/EIA-568-B.2-1.

#### 2.2.2.2 Patch Cords

Patch cords shall be cable assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at one end and 2 pair 110 type patch plug. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall be wired straight through; pins shall be paired to match T568A patch panel jack wiring per EIA ANSI/TIA/EIA-568-B. Patch cords shall be unkeyed. Patch cords shall be factory assembled. Patch cords shall conform to the requirements of EIA ANSI/TIA/EIA-568-B.2-1 for Category 5e. Furnish 500 patch cords. Cord lengths shall be 4 feet, 8 feet, 12 feet, and 16 feet. Quantity of each length as directed by Government.

#### 2.2.2.3 Terminal Blocks

Terminal blocks shall be wall mounted or rack mounted wire termination units as shown on drawings consisting of insulation displacement connectors mounted in plastic blocks, frames or housings. Blocks shall be type 66 which meet the requirements of EIA ANSI/TIA/EIA-568-B, and shall be rated for use with Category 5e cable in accordance with EIA ANSI/TIA/EIA-568-B.2-1 and shall meet the Link Test parameters as listed in EIA TIA/EIA-TSB-67 and supplemented by EIA ANSI/TIA/EIA-568-B.2-1. Blocks shall be mounted on standoffs and shall include cable management hardware. Insulation displacement connectors shall terminate 22 or 24 gauge solid copper wire as a minimum, and shall be connected in pairs so that horizontal cable and connected jumper wires are on separate connected terminals.

### 2.3 SCREENED TWISTED PAIR CABLE SYSTEM

#### 2.3.1 Screened Horizontal Cable

Screened horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-B.2-1 for Category 6. Cable shall be label-verified. Cable shield shall be an overall polyester/aluminum foil with copper drain wire. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated CMP per NFPA 70.

- a. Cables for the red system shall have a continuous red colored jacket.
- b. Cables for the black system shall have a continuous black colored jacket.
- c. Cables for the yellow system shall have a continuous yellow colored jacket.

### 2.3.2 Connecting Hardware

Connecting and cross-connecting hardware shall be the same category as the cable it serves. Hardware shall be in accordance with EIA ANSI/TIA/EIA-568-B, and shall ground cable screen.

#### 2.3.2.1 Telecommunications Outlets

Outlet assemblies used in the premises distribution system shall consist of modular jacks assembled into both simplex and duplex outlet assemblies in single or double gang covers as indicated on the drawings. Wall and desk outlet plates shall come equipped with the top or left jacks labeled "voice" and the bottom or right jacks labeled "data". Modular jacks shall be the same category as the cable they terminate and shall meet the requirements of EIA ANSI/TIA/EIA-568-B and shall meet the Link Test parameters as listed in EIA TIA/EIA-TSB-67 and supplemented by EIA ANSI/TIA/EIA-568-B.2-1. Modular jacks shall be designed for screened cable and fully shielded. Modular jack pin/pair configuration shall be T568A per EIA ANSI/TIA/EIA-568-B. Modular jacks shall be unkeyed and have icons for red jacks, black icons for black jacks, and yellow icons for yellow jacks. Faceplates shall be provided and shall be ivory in color. Mounting plates shall be provided for system furniture and shall match the system furniture in color.

#### 2.3.2.2 Patch Panels

Patch panels shall consist of eight-position modular jacks, with rear mounted type 110 insulation displacement connectors, fully shielded, with ground wire connection, arranged in rows or columns on 19 inch rack mounted or wall mounted panels as shown on Drawings. Patch panels shall be one unit in height. Jack pin/pair configuration shall be T568A per EIA ANSI/TIA/EIA-568-B. Jacks shall be unkeyed and have red icons for red jacks, black icons for black jacks, and yellow icons for yellow jacks. Panels shall be provided with labeling space. The modular jacks shall conform to the requirements of EIA ANSI/TIA/EIA-568-B, and shall be rated for use with screened Category 6 cable in accordance with EIA ANSI/TIA/EIA-568-B.2-1 and shall meet the Link Test parameters as listed in EIA TIA/EIA-TSB-67 and supplemented by EIA ANSI/TIA/EIA-568-B.2-1.

## 2.4 FIBER OPTIC CABLE SYSTEM

### 2.4.1 Backbone Cable

#### 2.4.1.1 Singlemode

Singlemode fiber optic backbone cable shall meet the requirements of ICEA S-83-596 and the following: operation at a center wavelength of 1310 and 1550 nm; core/cladding diameter 8.3 nominal/125 micrometer; maximum attenuation 2.0 dB/km at 1300 nm, 1.75 dB/km at 1550 nm. Numerical aperture for each fiber shall be a minimum of 0.10. Cable construction shall be tight buffered type. Cable shall be imprinted with fiber count and aggregate length at regular intervals. Individual fibers shall be color coded for identification. Cable shall be rated OFNR per NFPA 70.

### 2.4.2 Connecting Hardware

#### 2.4.2.1 Connectors

Connectors shall be SC type with ceramic ferrule material with a maximum

insertion loss of .5 dB. Connectors shall meet performance requirements of EIA ANSI/TIA/EIA-568-B. Connectors shall be field installable. Connectors shall utilize adhesive for fiber attachment to ferrule. Connectors shall terminate fiber sizes as required for the service.

#### 2.4.2.2 Patch Panels

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panels shall be 19 inch rack mounted panels. Patch panels shall provide strain relief for cables. Panels shall be provided with labeling space. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system.

### 2.5 EQUIPMENT RACKS

#### 2.5.1 Floor Mounted Open Frame

Floor mounted equipment racks shall be welded steel relay racks with uprights to mount equipment 19 inches wide. Uprights shall be 3 inch deep channel, 1-1/4 inches wide, drilled and tapped 12-24 in a 1/2 inch pattern.

Racks shall be provided with a standard top crossmember, and predrilled base plate to allow floor fastening. Open frame equipment racks shall be 7 feet in height and painted black for the black system and red for the red system. AC outlets shall be provided as shown.

#### 2.5.2 Cable Guides

Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inch equipment racks. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks by screws and/or nuts and lockwashers.

#### 2.5.3 Floor Mounted Cabinets

Equipment cabinets shall be floor mounted enclosures with side panels, acrylic plastic front doors, rear louvered metal doors, depth-adjustable front and rear mounting rails, and louvered top. Ventilation fans will be included. Vertical cable management devices shall be integral to the cabinet. Power strips with 6 outlets shall be provided within the cabinet.

Equipment racks shall mount equipment 19 inches wide and shall be 72 inches high and 30 inches deep. Cabinet exteriors shall be painted red/black/yellow to match the security level of the connecting cables.

### 2.6 EQUIPMENT MOUNTING BACKBOARD

Plywood backboards shall be provided, sized as shown, painted with white or light colored paint. Paint backboards red, black or yellow as noted on drawings.

### 2.7 TELECOMMUNICATIONS OUTLET BOXES

Electrical boxes for telecommunication outlets shall be 4-11/16 inch square by a minimum 2-1/8 inches deep with minimum 3/8 inch deep single or two gang plaster ring as shown.

## 2.8 INNERDUCT

Innerduct shall be corrugated type, sized as shown on drawings. Innerduct installed inside buildings shall be plenum rated and exceed the requirements of NFPA 90A and NFPA 262 for installation of plenums.

## 2.9 WEATHERPROOF PHONE ENCLOSURE

Weatherproof phone enclosure shall be constructed of durable glass-reinforced polyester. Enclosure shall have hinged door with latch and provide a positive seal when door is closed. Enclosure shall accommodate a standard wall phone.

## 2.10 DIRECT DIALING STATION

Direct dial telephone shall provide hands free communications with the telephone at the dialed number. Telephone shall be provided with amplified speaker, microphone, light emitting diode (LED) status indicator and call button. Pressing call button shall automatically dial programmed number. When answered by the calling party, a hands free conversation shall commence. Provide 120 VAC wall transformer for powering unit. Power telephone through unused cable pairs. Telephone shall be weatherproof with stainless steel faceplate. Telephone shall have an operating temperature range of minus 15 degrees F to 130 degrees F.

## 2.11 SPARE PARTS

Provide a minimum of the following. All products shall be as specified above.

- 1) Screened horizontal cable, red jacket: 5000 feet.
- 2) Screened horizontal cable, black jacket: 5000 feet.
- 3) Screened horizontal cable, yellow jacket: 1000 feet.

## PART 3 EXECUTION

### 3.1 SEPARATE AND ISOLATED CABLING SYSTEMS

Three separate and isolated cabling systems shall be provided for the red, black, and yellow systems. These three systems shall have no components, raceways, outlets, cable trays, cable racks, equipment racks, grounds, etc., in common.

For each of black, red, and yellow systems, the following shall apply:

- a. Black Outlets: Only black outlets may be fed by black cables installed in conduits or cable trays designated as black, and cables shall terminate on equipment racks designated as black. All grounds associated with the black system shall terminate on ground busses designated as black. Cable may only be installed on backboards designated as black.
- b. Red Outlets: Only red outlets may be fed by red cables installed in conduits or cable trays designated as red, and cables shall terminate on equipment racks designated as red. All grounds associated with the red system shall terminate on ground busses designated as red. Cable may only be installed on backboards designated as red.

- c. Yellow Outlets: Only yellow outlets may be fed by yellow cables installed in conduits or cable trays designated as yellow, and cables shall terminate on equipment racks designated as yellow. All grounds associated with the yellow system shall terminate on ground busses designated as yellow. Cable may only be installed on backboards designated as yellow.

### 3.2 INSTALLATION

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA ANSI/TIA/EIA-606A. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07840 FIRESTOPPING. Cable trays, conduits, outlets and raceways shall be installed in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Wiring shall be installed in accordance with EIA ANSI/TIA/EIA-568-B and as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Wiring, and terminal blocks and outlets shall be marked in accordance with EIA ANSI/TIA/EIA-606A. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables.

Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

#### 3.2.1 Horizontal Distribution Cable

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Fiber optic cables shall be installed either in conduit or through type cable trays to prevent microbending losses. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

#### 3.2.2 Riser and Backbone Cable

Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

#### 3.2.3 Telecommunications Outlets

##### 3.2.3.1 Faceplates

As a minimum each jack shall be labeled as to its function and a unique number to identify cable link. Labeling for red outlets shall be red, labeling for black outlets shall be black, labeling for yellow outlets shall be yellow.

### 3.2.3.2 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 6 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

### 3.2.4 Terminal Blocks

Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized.

### 3.2.5 Equipment Racks

Open frame equipment racks shall be bolted to the floor. Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

### 3.2.6 Rack Mounted Equipment

Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

### 3.2.7 Spare Parts

The Contractor shall provide spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests.

## 3.3 TERMINATION

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.

### 3.3.1 Unshielded Twisted Pair Cable

Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels. No cable shall be unterminated or contain unterminated elements. Pairs shall remain twisted together to within the proper distance from the termination as specified in EIA ANSI/TIA/EIA-568-B. Conductors shall not be damaged when removing insulation. Wire insulation shall not be damaged when removing outer jacket.

### 3.3.2 Screened Twisted Pair Cable

Each cable shall be terminated on panel-mounted connectors. Cables shall be grounded at patch panels using manufacturer's recommended methods. Wire insulation shall not be damaged when removing shield.

### 3.3.3 Fiber Optic Cable

Each fiber shall have connectors installed. The pull strength between the

connector and the attached fiber shall be not less than 25 pounds. The mated pair loss, without rotational optimization, shall not exceed 1.0 dB. Fiber optic connectors shall be installed per EIA ANSI/TIA/EIA-568-B.

### 3.4 GROUNDING

- a. Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with EIA ANSI/TIA/EIA-607A and Section 16415A ELECTRICAL WORK, INTERIOR.
- b. All grounding shall conform to the NFPA 70 and MIL-HDBK-419A Volumes I and II. Signal and power grounds shall be separate. All cable shields shall be grounded.
- c. Signal ground/drain wires shall conform to the standards in the MIL-HDBK-419A, Grounding, Bonding and Shielding.
- d. All cabinets/racks shall be grounded. All signal and equipment shall use the single point ground.
- e. Avoid ground loops. Ground all cable shields to signal ground at one end only using the facility single point ground system. Looping of shield grounds through connectors is acceptable, as long as it does not result in more than one ground attachment for cables using the single point ground policy. Isolate/insulate all shields and connect shields onto designated ground points.
- f. All signal ground wire shall be color-coded green with yellow stripe. Ground cables shall be marked with yellow tape at the termination and breakout points, or have green with yellow stripe insulation where exposed to view (a minimum of every 8 feet if installed in open duct). See MIL-HDBK-419A, Volume II for ground run details. Insulated wire must be used in the ground system above ground and from the ground system to a ground bus. A wire bend radius of 6-inches or more shall be observed for all ground runs.
- g. Provide separate 6 AWG signal ground runs from each cabinet ground bus to the station ground bus.
- h. Signal and power grounds shall be kept separate except where specifically shown connected together. Terminal block ground jumpers or cable shield grounding tails shall be minimum 22 AWG and shall not exceed 12 inches in length for 16 to 22 AWG, and 70 inches for 14 to 12 AWG. Minimum 10 AWG wire up to 50 foot runs, and 6 AWG for runs over 50 feet shall be used for separate building ground cabinet frame/rack frame/distribution system grounding where necessary. Limit ground runs to the following distances for the indicated sizes:

18 AWG	2 feet
16 AWG	4 feet
14 AWG	6 feet
12 AWG	10 feet
10 AWG	16 feet
8 AWG	25 feet
6 AWG	40 feet
4 AWG	65 feet

2 AWG	100 feet
1 AWG	130 feet
1/0 AWG	160 feet
2/0 AWG	200 feet

- i. Provide external signal ground systems per MIL-HDBK-419A and EIA ANSI/TIA/EIA-607A. Provide Red, Black, and Yellow separate ground boxes. Tie the external signal ground system to building and any other local grounds through minimum 6AWG wire buried between the earth ground systems, or between the closest points to earth where buried connectivity is not possible. Do not connect signal ground to lightning grounds except at earth contact points. The Contractor shall provide a copper Main Ground Bus (MGB) which shall be the hub of the basic grounding system providing a common point of connection for ground from outside cable, MDF, and equipment. The MGB shall be enclosed where not in a telephone frame area with open connections.
- j. All exposed non-current carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals shall be grounded using minimum 12 AWG wire. Ground wires shall be connected with screw-down connectors to the bus.
- k. Shielded cables shall be grounded at equipment rack patch panels. Grounding of shielded cables at patch. Cable shields must then be run to a metallic back shell and the patch frame shall be isolated from the cabinet for this method of cable shield grounding to be effective.
- l. Ground access boxes shall be equipped with a copper 225 amp panelboard neutral bus bar installed in a wall mounted NEMA Type 1 enclosure.

### 3.5 ADDITIONAL MATERIALS

The Contractor shall provide the following additional materials required for facility startup.

- a. 30 of each type outlet.
- b. 10 of each type cover plate.
- c. 1 of each type terminal block for each telecommunications closet.
- d. 1 Set of any and all special tools required to establish a cross connect and to change and/or maintain a terminal block.

### 3.6 ADMINISTRATION AND LABELING

#### 3.6.1 Labeling

##### 3.6.1.1 Labels

All labels shall be in accordance with EIA ANSI/TIA/EIA-606A.

##### 3.6.1.2 Cable

All cables will be labeled using color labels on both ends with unencoded identifiers per EIA ANSI/TIA/EIA-606A.



### 3.6.1.3 Termination Hardware

All workstation outlets and patch panel connections will be labeled using color coded labels with unencoded identifiers per EIA ANSI/TIA/EIA-606A.

## 3.7 TESTING

Materials and documentation to be furnished under this specification are subject to inspections and tests. All components shall be terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made in accordance with the approved Test Plan submitted by the Contractor, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided. The Contractor shall submit Test Reports as they are completed.

### 3.7.1 Unshielded Twisted Pair Tests

All metallic cable pairs shall be tested for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals shall be corrected. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room. Backbone wiring shall be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective communications closets. These test shall be completed and all errors corrected before any other tests are started.

### 3.7.2 Category 6 Circuits

All category 6 circuits shall be tested using a test set that meets the Class II accuracy requirements of EIA TIA/EIA-TSB-67 standard, including the additional tests and test set accuracy requirements of EIA ANSI/TIA/EIA-568-B.2-1. Testing shall use the Basic Link Test procedure of EIA TIA/EIA-TSB-67, as supplemented by EIA ANSI/TIA/EIA-568-B.2-1. Cables and connecting hardware which contain failed circuits shall be replaced and retested to verify the standard is met. Ground potential difference between wiring closets, ground potential difference between patch panel and wall outlet, and ground path resistance shall be tested per IBM GA27-3361-07.

### 3.7.3 Fiber Optic Cable

Unless stated otherwise, tests shall be performed from both ends of each circuit. Connectors shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist. Each circuit leg and complete circuit shall be tested for insertion loss at 1310 and 1550 nm using a light source similar to that used for the intended communications equipment. High-resolution optical time domain reflectometer (OTDR) tests shall be performed from one end of each fiber. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

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## SECTION 16711A

## TELEPHONE SYSTEM, OUTSIDE PLANT

11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C62.61 (1993) Gas Tube Surge Arresters on Wire  
Line Telephone Circuits

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2239 (1999) Polyethylene (PE) Plastic Pipe  
(SIDR-PR) Based on Controlled Inside  
Diameter

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA TIA/EIA-455-81B (2000) FOTP-81 Compound Flow (Drip) Test  
for Filled Fiber Optic Cable

EIA ANSI/EIA/TIA-455-30B (1991) FOTP-30 Frequency Domain  
Measurement of Multimode Optical Fiber  
Information Transmission Capacity

EIA ANSI/EIA/TIA-455-53A (1990) FOTP-53 Attenuation by Substitution  
Measurement for Multimode Graded-Index  
Optical Fibers or Fiber Assemblies Used in  
Long Length Communications Systems

EIA ANSI/EIA/TIA-455-78A (1990; R 1998) FOTP-78 Spectral  
Attenuation Cutback Measurement for Single  
Mode Optical Fibers

EIA ANSI/TIA/EIA-568-A (1995; Addendum 3 1998) Commercial  
Building Telecommunications Cabling  
Standard

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1999) National Electrical Safety Code

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

## U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 345-50	(1979) Trunk Carrier Systems
RUS REA Bull 1751F-641	(1995) Construction of Buried Plant
RUS Bull 1753F-201	(1976) Acceptance Tests and Measurements of Telephone Plant
RUS Bull 1753F-205	(1993) REA Specification for Filled Telephone Cables
RUS REA Bull 1753F-207	(1994) Terminating (TIP) Cable
RUS REA Bull 1753F-208	(1993) Filled Telephone Cables with Expanded Insulation
RUS REA Bull 1753F-601	(1994) REA Specification for Filled Fiber Optic Cables

## UNDERWRITERS LABORATORIES (UL)

UL 497	(1995; Rev Oct 1999) Protectors for Paired Conductor Communication Circuits
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## 1.2 SYSTEM DESCRIPTION

The outside plant system shall consist of all cable, conduit, manholes, poles, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, terminating cables, lightning and surge protection modules at the entry facility. The work consists of furnishing, installing, testing and making operational a complete outside plant system for continuous use.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Telephone System; G, RE  
Installation; G, RE

Detail drawings, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, and catalog cuts. Detail drawings shall also contain complete configuration information, wiring diagrams and any other details required to demonstrate that the cable system has been coordinated to support the transmission systems identified in the specifications and drawings. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operations.

## Record Drawings; G, RE

Record drawings for the installed wiring system showing the actual location of all cable terminations, splices, routing, and size and type of all cables. The identifier for each termination and cable shall appear on the drawings. The drawings shall include gauge and pair or fiber count for each cable, duct and innerduct arrangement, or conductor assignment of outside plant, and protector and connector block layout at the termination points after installation.

## SD-03 Product Data

Spare Parts; G, RE  
Equipment; G, RE

A data list of recommended spare parts, tools, and test equipment for each different item of material and equipment specified prior to beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Installation; G, RE

Printed copies of the manufacturer's recommendations for the material being installed, prior to installation. Installation of the item will not be allowed to proceed where installation procedures, or any part thereof, are required to be in accordance with those recommendations until the recommendations are received and approved.

Acceptance Tests; G, RE

Test plans defining all tests required to ensure that the system meets specified requirements. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.

## SD-06 Test Reports

Acceptance Tests; G, RE

Test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis.

## SD-07 Certificates

Telephone System; G, RE

Proof that the items furnished under this section conform to the specified requirements in FCC, ICEA, REA, RUS, ANSI, ASTM, NFPA, EIA, or UL, where materials and equipment are so specified.

Qualifications; G, RE

The qualifications of the manufacturer, splicer, and

installation supervisor as specified.

#### 1.4 QUALIFICATIONS

##### 1.4.1 Cable Installers

Installation shall be under the direct supervision of an individual with a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components.

##### 1.4.2 Cable Splicing and Termination

All cable splicers shall have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices shall be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

##### 1.4.3 Manufacturers

The cable, equipment, and hardware provided shall be from manufacturers that have a minimum of 3 years experience in producing the types of cable, equipment, and hardware specified.

#### 1.5 DELIVERY AND STORAGE

##### 1.5.1 Cable Requirements

All cable shall be shipped on reels. The diameter of the drum shall be large enough to prevent damage to the cable during reeling and unreeling. The reels shall be constructed to prevent damage during shipment and handling. The outer end of the cable shall be securely fastened to the reel head to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel, or into a housing on the inner slot of the drum, with sufficient length to make it available for testing. The inner end shall be fastened to prevent the cable from becoming loose during installation. End seals shall be applied to each of the cables to prevent moisture from entering the cable. The reels with cable shall be suitable for outside storage conditions when the temperature ranges from minus 40 to plus 148 degrees F, with relative humidity from 0 to 100 percent.

##### 1.5.2 Equipment

All equipment shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants, in accordance with the manufacturer's requirements.

#### 1.6 Telephone System

Submit shop drawings and proper certification of telephone system.

#### 1.7 Record Drawings

Submit record drawings to Contracting Officer as indicated above.

#### 1.8 Spare Parts

Provide spare parts as indicated in Contract Drawings and Specifications.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 2 years prior to bid opening. Each major component of equipment shall have the manufacturer's name and type identified on the equipment. All products supplied shall be specifically designed and manufactured for use with outside plant communications systems. All items of the same class of equipment shall be the products of a single manufacturer.

### 2.2 CABLE

#### 2.2.1 Copper Conductor Cable

Copper conductor cable shall conform to the following:

##### 2.2.1.1 Underground

Cable shall be manufactured per RUS Bull 1753F-205 or RUS REA Bull 1753F-208. A 8 mil coated aluminum or 5 mil copper metallic shield shall be provided.

##### 2.2.1.2 Screened

Screened cable shall comply with RUS Bull 1753F-205 or RUS REA Bull 1753F-208.

#### 2.2.2 Fiber Optic Cable

Fiber optic cable shall be specifically designed for outside use with tight or loose buffer construction. The tight buffer optical fiber cable shall consist of a central glass optical fiber surrounded by a soft intermediate buffer to allow for thermal expansions and proper fitting of the secondary buffer. The loose buffer optical fiber cable shall have the glass optical fiber within a filled loose tube. All fiber optic cables used shall conform to the requirements of RUS REA Bull 1753F-601 including any special requirements made necessary by a specialized design..

##### 2.2.2.1 Cable Cores

A central, nonmetallic core member shall be included to serve as a cable core foundation to reduce strain on the fibers, but not to serve as a pulling strength member.

##### 2.2.2.2 Optical Fiber

Single-mode optical fibers shall be Class IV. Multi-mode optical fibers shall be Class Ia.

##### 2.2.2.3 Performance Requirements

The fiber optic cable shall comply with the specified mechanical performance requirements while used in buried and underground duct applications where the temperature varies from minus 5 to plus 140 degrees F. Optical performance degradation shall be less than 5 percent of the optical performance requirements in the temperature range of minus 5 to plus 140 degrees F. The fiber optic cable shall not be damaged in storage



where the temperature may vary from minus 40 to plus 148 degrees F.

## 2.3 DUCT

### 2.3.1 Duct/Conduit

Conduit shall be furnished as specified in Sections 16415A ELECTRICAL WORK, INTERIOR and 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown on project drawings.

### 2.3.2 Innerduct

Innerduct shall be SIDR 11.5 polyethylene plastic pipe conforming to ASTM D 2239.

## 2.4 CONNECTOR BLOCKS

Connector blocks consisting of flame-retardant molded plastic fastened to a metal mounting bar shall be provided to terminate the outside plant cable as shown. The connector blocks shall be of 100-pair block size and equipped with protection modules. The connector blocks shall be 24 gauge stub type. The cable stubs shall be 100 pair and conform to RUS REA Bull 1753F-207.

## 2.5 PROTECTOR MODULES

The protector modules shall be of the two-element gas tube type. Protection modules shall be maximum duty, A>20 kA, B>1000, C>200A where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current per ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, be equipped with an external spark gap and heat coils, and shall comply with UL 497.

## 2.6 FIBER-OPTIC TERMINATIONS

### 2.6.1 Fiber Optic Connectors

All outside plant fiber strands shall be terminated in a SC type fiber optic connector for single mode fibers and ST for multi-mode fibers, with ceramic ferrule material and a maximum insertion loss of 0.5 dB. Connectors shall meet performance standards of EIA ANSI/TIA/EIA-568-A. If pre-connectorized cable assemblies or pigtailed are used, the connectors shall be terminated on a 10 foot length of single-fiber cable. The single-fiber cable shall contain a buffered optical fiber of the same type and specification as that used in the multi-fiber cable.

### 2.6.2 Fiber Optic Patch Panels

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panels shall be 19 inch rack mounted or wall mounted as shown. Patch panels shall provide strain relief for cables. Panels shall be labeled with alphanumeric x-y coordinates. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system.

## 2.7 MISCELLANEOUS ITEMS

### 2.7.1 Grounding Braid

Grounding braid shall provide low electrical impedance connections for dependable shield bonding. The braid shall be made from flat tin-plated copper.

### 2.7.2 Warning Tape

Marking and locating tape shall be acid and alkali resistant polyethylene film, 6 inches wide with a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep and 6 inches below duct bank. The metallic core shall be encased in a protective jacket or provided with other means to protect it from corrosion and shall be specifically manufactured for marking and locating underground utilities. The warning tape shall be orange in color and continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" at not more than 48 inch intervals.

## PART 3 EXECUTION

### 3.1 INSTALLATION

All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. All installation work shall be done in accordance with the safety requirements set forth in the general requirements of IEEE C2 and NFPA 70.

#### 3.1.1 Cable Inspection and Repair

All cable and wire used in the construction of the project shall be handled with care. Each reel shall be inspected for cuts, nicks or other damage. All damage shall be repaired to the satisfaction of the Contracting Officer. The reel wrap shall remain intact on the reel until the cable or wire is ready to be placed.

#### 3.1.2 Underground Cable

Underground cable installation shall be accomplished in accordance with the requirements set forth in RUS REA Bull 1751F-641.

##### 3.1.2.1 Cable Pulling

For cable installed in ducts and conduit, a cable feeder guide shall be used, between the cable reel and the face of the duct and conduit, to protect the cable and guide it into the duct and conduit as it is paid off the reel. As the cable is paid off the reel, it shall be inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being kinked or crushed. A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is paid off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. The mechanical stress placed upon a cable during installation shall not cause the cable to be twisted or stretched.

### 3.1.2.2 Penetrations for Cable Access

Penetrations in walls, ceilings or other parts of the building, made to provide for cable access, shall be caulked and sealed. Where conduits and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in section 07840 FIRESTOPPING. Fire stopped penetrations shall not compromise the fire rating of the walls or floors. All underground building entries shall be through waterproof facilities.

### 3.1.2.3 Cable Bends

Telephone cable bends shall have a radius of not less than 10 times the cable diameter. Only large radius sweeps shall be used in conduit runs and shall not exceed a cumulative 90 degrees between manholes.

### 3.1.3 Ducts

Duct systems shall be installed in accordance with Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Manholes shall be placed in line with the main duct. Splice cases shall be mounted in the center on the long sides. Lateral conduits shall exit the long sides near the corners.

#### 3.1.3.1 Innerduct Installation

Innerduct shall be pulled through existing duct-manhole system in continuous sections. Splices, joints, couplings, or connections of any type will not be allowed between manholes. Innerduct shall be plugged at both ends with polyurethane foam duct seal; this material shall also be inserted between the innerduct and the duct if cables are placed in the innerducts. Only one cable shall be installed in a given innerduct. Existing and new unoccupied innerducts shall be trimmed leaving 2 inches exposed.

#### 3.1.3.2 Pull Cord

Pull cords of 3/8 inch polypropylene shall be installed in all unused ducts and inner-ducts with a minimum of 2 feet spare cord protruding from each end.

### 3.1.4 Surge Protection

Except for fiber optic cable, all cables and conductors, which serve as communication lines, shall have surge protection meeting the requirements of RUS 345-50 installed at the entry facility.

## 3.2 GROUNDING

Except where specifically indicated otherwise, all exposed non-current carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals shall be grounded. Grounding shall be in accordance with requirements of NFPA 70, Articles 800-33 and 800-40.

### 3.2.1 Incoming Outside Plant Cables

All incoming outside plant cable shields shall be bonded directly to the TMGB or the closest TGB.

### 3.2.2 Shields

The shields of all incoming cables shall not be bonded across the splice to the cable stubs.

### 3.2.3 Protection Assemblies

The protector assemblies shall be mounted directly on the vertical frame ironwork. The assemblies mounted on each vertical frame shall be connected with a No. 6 AWG copper conductor to provide a low resistance path to the TGB.

## 3.3 ACCEPTANCE TESTS

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test; testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. The test plans shall define all the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.

### 3.3.1 Copper Conductor Cable

The following acceptance tests shall be performed in accordance with RUS Bull 1753F-201:

- a. Conductor continuity.
- b. Conductor insulation resistance.
- c. Structural return loss.
- d. Cable insertion loss and loss margin at carrier frequencies.
- e. DC loop resistance.

### 3.3.2 Fiber Optic Cable

Two optical tests shall be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test shall be performed on all multi-mode optical fibers. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

#### 3.3.2.1 OTDR Test

The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings, improper splices, for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 3280 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of

connector signature. The OTDR test shall be conducted in accordance with EIA TIA/EIA-455-81B for single-mode fiber and EIA ANSI/EIA/TIA-455-78A for multi-mode fiber. Splice losses shall not exceed 0.1db. Attenuation losses shall not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber. Attenuation losses shall not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multi-mode fiber.

#### 3.3.2.2 Attenuation Test

End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 850 nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met. The measurement method shall be in accordance with EIA ANSI/EIA/TIA-455-53A.

#### 3.3.2.3 Bandwidth Test

The end-to-end bandwidth of all multi-mode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with EIA ANSI/EIA/TIA-455-30B.

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## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170 (1957) Electrical Performance Standards -  
Monochrome Television Studio Facilities

EIA ANSI/EIA-375-A (1974) Direct View Monochrome Closed  
Circuit Television Monitors 525/60  
Interlaced 2:1

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE C62.41 (1991) Recommended Practice for Surge  
Voltages in Low-Voltage AC Power Circuits

IEEE Std 142 (199) Recommended Practice for Grounding  
of Industrial and Commercial Power Systems  
- Green Book

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## UNDERWRITERS LABORATORIES (UL)

UL 497B (1999) Safety Protectors for Data  
Communications and Fire Alarm Circuits

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## 1.2 SYSTEM DESCRIPTION

## 1.2.1 General

The Contractor shall configure the system as described and shown. All television equipment shall conform to EIA 170 specifications. The system shall include all connectors, adapters, and terminators necessary to interconnect all equipment. The Contractor shall also supply all cabling

necessary to interconnect the closed circuit television (CCTV) equipment installed in the Security Center, and interconnect equipment installed at remote control/monitoring stations. If the CCTV system is installed for use with an Electronic Security System (ESS) the Contractor shall interface the CCTV system with the ESS.

#### 1.2.2 System Overall Reliability Requirement

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours, and shall be calculated based on the configuration specified in paragraph "System Overall Reliability Calculations."

#### 1.2.3 Power Line Surge Protection

All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

#### 1.2.4 Video and Sync Signal Transmission Line Surge Protection

All cable, except fiber optic cable, used for sync or video signal transmission shall include protective devices to safeguard the CCTV equipment against surges. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. The surge suppression device shall be capable of dissipating not less than 1500 watts for 1 millisecond, and the response time from zero volts to clamping shall not be greater than 5 nanoseconds. Fuses shall not be used for surge protection.

#### 1.2.5 Control Line Surge Protection

All cables and conductors, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against surges and shall have surge protection installed at each end. Protection shall be furnished at the equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following waveforms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

#### 1.2.6 Power Line Conditioners

A power line conditioner shall be furnished for the security console CCTV equipment. The power line conditioner shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner shall be sized for 125 percent of the actual connected kVA load. Characteristics of the power line conditioner shall be as follows:

- a. At 85 percent load, the output voltage shall not deviate by more

than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

- b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.
- c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

#### 1.2.7 Environmental Conditions

##### 1.2.7.1 Field Equipment

The cameras and all other field equipment shall be rated for continuous operation under ambient environmental conditions of 14 degrees to 120 degrees F using no auxiliary heating or cooling equipment. Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, wind loading, ice loading, and vibration conditions specified or encountered for the installed location.

##### 1.2.7.2 Security Center Equipment

Security Center and remote control/monitoring station equipment shall, unless designated otherwise, be rated for continuous operation under ambient environmental conditions of 60 degrees F to 85 degrees F and a relative humidity of 20 to 80 percent.

#### 1.2.8 Electrical Requirements

Electrically powered IDS equipment shall operate on 120 volt 60 Hz AC sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

### 1.3 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

All items of computer software and technical data (including technical data which relates to computer software), which are specifically identified in this specification shall be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, Section 01330 SUBMITTAL PROCEDURES, and in accordance with the Contract Data Requirements List (CDRL), DD Form 1423, which is attached to and thereby made a part of this contract. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

#### 1.3.1 Group I Technical Data Package

##### 1.3.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. CCTV system console installation, block diagrams, and wiring diagrams.

- c. Security center CCTV equipment installation, interconnection with console equipment, block diagrams and wiring diagrams.
- d. Remote control/monitoring station installation, interconnection to security center including block diagrams and wiring diagrams.
- e. Camera wiring and installation drawings.
- f. Pan/tilt mount wiring and installation drawings.
- g. Interconnection with video signal transmission system, block diagrams and wiring diagrams.
- h. Surge protection device installation.
- i. Details of interconnection with ESS.

#### 1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials and equipment and security center equipment provided under this specification.

#### 1.3.1.3 System Description and Analyses

The data package shall include complete system descriptions, analyses and calculations used in sizing the equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Switcher matrix size.
- b. Camera call-up response time.
- c. System start up and shutdown operations.
- d. Switcher programming instructions.
- e. Switcher operating and maintenance instructions.
- f. Manuals for CCTV equipment.
- g. Data entry forms.

#### 1.3.1.4 Software Data

The data package shall consist of descriptions of the operation and capability of system and application software as specified.

#### 1.3.1.5 Overall System Reliability Calculations

The data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability. The calculations shall be based on all CCTV equipment associated with one camera circuit and the console CCTV equipment, excluding the data transmission media (DTM).

#### 1.3.1.6 Certifications

All specified manufacturer's certifications shall be included with the data package.

#### 1.3.1.7 Key Control Plan

The Contractor shall provide a key control plan. The key control plan shall include the following:

- a. Procedures that will be used to log and positively control all keys during installation.
- b. A listing of all keys and where they are used.
- c. A listing of all persons allowed access to the keys.

#### 1.3.2 Group II Technical Data Package

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, provide (with the report) specification sheets, or written functional requirements to support the findings, and a cost estimate to correct the deficiency. The Contractor shall not correct any deficiency without written permission from the Government.

#### 1.3.3 Group III Technical Data Package

The Contractor shall prepare test procedures and reports for the predelivery test. The Contractor shall deliver the predelivery test procedures to the Government for approval. After receipt by the Contractor of written approval of the predelivery test procedures, the Contractor may schedule the predelivery test. The final predelivery test report shall be delivered after completion of the predelivery test.

#### 1.3.4 Group IV Technical Data Package

The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the tests. The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph "Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

##### 1.3.4.1 Operation and Maintenance Manuals

A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

##### 1.3.4.2 Training Documentation

Lesson plans and training manuals for the training phases, including type of training to be provided with a sample training report, and a list of

reference material, shall be delivered for approval.

#### 1.3.4.3 Data Entry

The Contractor shall enter all data needed to make the system operational. The Contractor shall deliver the data to the Government on data entry forms, utilizing data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify and request from the Government, any additional data needed to provide a complete and operational CCTV system. The completed forms shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

#### 1.3.4.4 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install all graphics needed to make the system operational. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 by 10 inches in size, of each type of graphic to be used for the completed CCTV system. If the video switcher does not use a monitor for display of system information, the Contractor shall provide examples of the video annotation used for camera identification. The graphics examples shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

#### 1.3.5 Group V Technical Data Package

Final copies of each of the manufacturer's commercial manuals arranged as specified bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. The number of copies of each manual to be delivered shall be as specified on DD Form 1423.

##### 1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

##### 1.3.5.2 Hardware Manual

A manual shall describe all equipment furnished, including:

- a. General hardware description and specifications.
- b. Installation and checkout procedures.

- c. Equipment electrical schematics and layout drawings.
- d. System schematics and wiring lists.
- e. System setup procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.3.5.3 Software Manual

The software manual shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation, including:

- a. Definitions of terms and functions.
- b. Procedures for system boot-up.
- c. Description of using the programs.
- d. Description of required operational sequences.
- e. Directory of all disk files.
- f. Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer.

#### 1.3.5.4 Operator's Manual

The operator's manual shall explain all procedures and instructions for operation of the system including:

- a. Video switcher.
- b. Video multiplexer.
- c. Cameras and video recording equipment.
- d. Use of the software.
- e. Operator commands.
- f. System start-up and shut-down procedures.
- g. Recovery and restart procedures.

#### 1.3.5.5 Maintenance Manual

The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.3.5.6 As-Built Drawings

The Contractor shall maintain a separate set of drawings, elementary

diagrams and wiring diagrams of the CCTV system to be used for as-built drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the CCTV system and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the final system drawings, a representative of the Government will review the final system work with the Contractor. If the final system work is not complete, the Contractor will be so advised and shall complete the work as required. Final drawings submitted with the endurance test report shall be finished drawings on mylar or vellum, and as AutoCAD or Microstation files on CD-ROM.

#### 1.4 TESTING

##### 1.4.1 General

The Contractor shall perform predelivery testing, site testing, and adjustment of the completed CCTV system. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific test procedures.

##### 1.4.2 Test Procedures and Reports

Test procedures shall explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

#### 1.5 TRAINING

##### 1.5.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. If the CCTV system is being installed in conjunction with an ESS, the CCTV training shall be concurrent and part of the ESS training. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. Where the Contractor presents portions of the course through the use of audio-visual material, copies of the audio-visual materials shall be delivered to the Government, either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is 8 hours of instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. For guidance in planning the required instruction, the Contractor should assume the attendees will have a high school education or equivalent. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.



### 1.5.2 Operator's Training

The course shall be taught at the project site for five consecutive training days during or after the Contractor's field testing. A maximum of 12 personnel will attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of classroom instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The Contractor shall prepare a written report after the completion of the course. The Contractor shall list in the report the times, dates, attendees and material covered at each training session. The Contractor shall describe the skill level of each student at the end of this course. The Contractor shall submit the report before the end of the performance verification test. The course shall include:

- a. General CCTV hardware, installed system architecture and configuration.
- b. Functional operation of the installed system and software.
- c. Operator commands.
- d. Alarm interfaces.
- e. Alarm reporting.
- f. Fault diagnostics and correction.
- g. General system maintenance.
- h. Replacement of failed components and integration of replacement components into the operating CCTV system.

## 1.6 MAINTENANCE AND SERVICE

### 1.6.1 General Requirements

The Contractor shall provide all services required and equipment necessary to maintain the entire CCTV system in an operational state as specified for a period of 1 year after completion of the endurance test, and shall provide all necessary material required for the work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other unscheduled work.

### 1.6.2 Description of Work

The adjustment and repair of the CCTV system includes all computer equipment, software updates, signal transmission equipment, and video equipment. Provide the manufacturer's required adjustments and all other work necessary.

### 1.6.3 Personnel

Service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

### 1.6.4 Schedule of Work

The Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

- a. Visual checks and operational tests of the CPU, switcher, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
- b. Run system software and correct all diagnosed problems.
- c. Resolve any previous outstanding problems.

### 1.6.5 Emergency Service

The Government will initiate service calls when the CCTV system is not functioning properly. Qualified personnel shall be available to provide service to the complete CCTV system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 12 hours after receiving a request for service. The CCTV system shall be restored to proper operating condition within 2 calendar days after receiving a request for service.

### 1.6.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

### 1.6.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the CCTV system.

### 1.6.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is completed.

### 1.6.9 System Modifications

The Contractor shall make any recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

### 1.6.10 Software

The Contractor shall recommend all software updates to the Government for approval. Upon Government approval, updates shall be accomplished in a timely manner, fully coordinated with the CCTV system operators, operation in the system verified, and shall be incorporated into the operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the manufacturer's software.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

All system hardware and software components shall be produced by manufacturers regularly engaged in the production of CCTV equipment. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Equipment located at the security center or a remote control/monitoring station shall be rack mounted as shown. Both Television and Computing devices shall comply with 47 CFR 15, Subpart B.

### 2.2 ENCLOSURES

The Contractor shall provide metallic enclosures as needed for equipment not housed in racks or supplied with a housing. The enclosures shall be as specified or shown.

#### 2.2.1 Interior

Enclosures to house equipment in an interior environment shall meet the requirements of NEMA 250 Type 12.

#### 2.2.2 Exposed-to-Weather

Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250 Type 4X.

### 2.3 LOCKS AND KEY-LOCK OPERATED SWITCHES

#### 2.3.1 Locks

Locks shall be provided on system enclosures for maintenance purposes shall be UL listed, round-key type, with three dual, one mushroom, and three plain pin tumblers. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance locks shall be keyed alike and only two

keys shall be furnished for all of these locks.

#### 2.3.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, with three dual, one mushroom, and three plain pin tumblers. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch.

#### 2.4 SOLID STATE CAMERAS

##### 2.4.1 High Resolution Color Camera

All electronic components and circuits shall be solid state. Signal-to-noise ratio shall not be less than 50 dB unweighted. The camera shall exhibit no geometric distortion. The lens mount shall be a C-mount, and the camera shall have a back focus adjustment. The camera shall operate from 14 to 131 degrees F without auxiliary heating or cooling, and with no change in picture quality or resolution. The camera shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 24 Volts.

##### 2.4.1.1 Solid State Image Array

The camera shall have a solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA 330. The camera shall provide not less than 460 lines of horizontal resolution, and resolution shall not vary over the life of the camera. The imager shall have at least 768 horizontal x 494 vertical active picture elements.

##### 2.4.1.2 Sensitivity

Camera shall provide full video output with the infrared cut-off filter installed, without camera automatic gain, and a scene reflectivity of 75 percent using an f/1.2 lens given a camera faceplate illumination at 3200K of 0.2 footcandle minimum.

##### 2.4.1.3 Camera Synchronization

The camera shall have an input for external sync, and shall automatically switch over to internal sync if external sync is not present. The camera shall also have the capability of synchronization by line-locking to the AC power line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.

##### 2.4.1.4 Connectors

Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions. Video signal output connector shall be a BNC. Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors. A connector shall be provided for external sync input.

##### 2.4.1.5 Automatic Circuits

The camera shall have circuitry for through the lens (TTL) white balancing,

fixed white balancing, and automatic gain control.

#### 2.4.2 Dome Cameras

##### 2.4.2.1 Interior Dome Camera System

An interior dome camera system shall be provided with integral camera installed and integrated into the dome housing. The camera shall meet the requirements of Paragraph: High Resolution Color Camera as shown or specified. The dome housing shall be nominally 6 inches and shall be furnished in a pendant mount or ceiling mount as shown. The lower dome shall be tinted acrylic and shall have a light attenuation factor of not more than 1 f-stop. The housing shall be equipped with integral pan/tilt complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt shall have heavy duty bearings and hardened steel gears. The pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees.

Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second. There shall not be less than 64 preset positions, with positioning speeds of at least 360 degrees per second in the automatic mode, and not less than 120 degrees per second in the manual positioning mode, with a positioning accuracy of plus or minus 1/2 degree. Each set of preset position data shall include auto focus, auto iris, pan, tilt, and zoom functions. The system shall be able to automatically scan between any two electronically-set limits, and shall be able to operate in the "tour" mode covering up to all presets in a user defined sequence. The dome system shall withstand temperature ranges from minus 22 to 122 degrees F over a humidity range of 0 to 90 percent, non-condensing. PAN/TILT/ZOOM functions shall be super-imposed on composite video signal.

##### 2.4.2.2 Exterior Dome Camera System

An exterior dome camera system shall be provided with integral camera installed and integrated into the dome housing. The camera shall have a minimum horizontal resolution of 425 lines (color). The dome housing shall be nominally 6 inches and shall be furnished in a NEMA 4 pendant mount, pole mount, ceiling mount, surface mount, or corner mount as shown. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall protect the internal drives, positioners, and camera from the environment encountered for camera operation. The lower dome shall be tinted acrylic and shall have a light attenuation factor of not more than 1 f-stop. An integral heater, sized to maintain the lower dome above the dew point, shall be part of the camera system. The housing shall be equipped with integral pan/tilt complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt shall have heavy duty bearings and hardened steel gears. The pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees.

Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second. There shall not be less than 99 preset positions, with positioning speeds of at least 360 degrees per second in the automatic mode, and not less than 120 degrees per second in the manual positioning mode, with a positioning accuracy of plus or minus 1/2 degree. Each set of preset position data shall include auto focus, auto iris, pan, tilt, and zoom functions. The system shall be able to automatically scan between any two electronically-set limits, and shall be able to operate in the "tour" mode covering up to all presets in a user defined sequence. The dome system shall withstand temperature ranges from minus 40 to 122 degrees F over a humidity range of 0 to 90 percent, non-condensing. PAN/TILT/ZOOM functions shall be super-imposed on composite video signal.

## 2.5 CAMERA LENSES

Camera lenses shall be all glass with coated optics. The lens mount shall be a C or CS mount, compatible with the cameras selected. The lens shall be supplied with the camera, and shall have a maximum f-stop opening of f/1.2 or the maximum available for the focal length specified. The lens shall be equipped with an auto-iris mechanism unless otherwise specified. Lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors, wiring, receiver/drivers, and controls as needed to operate the lens functions. Lenses shall have sufficient circle of illumination to cover the image sensor evenly. Lenses shall not be used on a camera with an image format larger than the lens is designed to cover. Lens focal lengths shall be as shown or specified in the manufacturer's lens selection tables.

## 2.6 CAMERA HOUSINGS AND MOUNTS

The camera and lens shall be enclosed in a tamper resistant housing as specified below. Any ancillary housing mounting hardware needed to install the housing at the camera location shall be provided as part of the housing. The camera and lens contained in a camera housing shall be installed on a camera support as shown. Any ancillary mounting hardware needed to install the support and to install the camera on the support shall be provided as part of the support. The camera support shall be capable of supporting the equipment to be mounted on it including wind and ice loading normally encountered at the site.

### 2.6.1 Interior Dome Housing

An interior dome housing shall be provided for each camera as shown. The dome housing shall be a ceiling mount. The lower dome shall be black opaque acrylic and shall have a light attenuation factor of not more than 1 f-stop.

### 2.6.2 Exterior Dome Housing

An exterior dome housing shall be provided for each exterior camera. The dome housing shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mount as shown. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be purged of atmospheric air and pressurized with dry nitrogen, shall be equipped with a fill valve and overpressure valve, and shall have a pressure indicator visible from the exterior. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections

required for operation of the camera and lens shall be supplied.

## 2.7 VIDEO MONITOR

### 2.7.1 Color Video Monitor (17 inch)

All electronic components and circuits shall be solid state LCD type. The monitor shall have a 1280 x 1024 pixels and 500 TV lines of resolution. The video input shall allow switchable loop-through or 75 ohm termination.

The monitor shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 105 to 130 volts. Monitor shall have a minimum luminance of 430 cd/m<sup>2</sup>, contrast ratio of 400:1 minimum and 150 degrees horizontal x 140 degrees vertical viewing angle.

### 2.7.2 Configuration

The monitor shall be configured in a desk or wall mount as shown. Monitors shall not interfere with each other when rack mounted or operated next to each other as described in EIA ANSI/EIA-375-A. Provide wall adjustable wall brackets with an adjustment range of -5 degrees to +15 degrees vertical.

### 2.7.3 Controls

Front panel controls shall be provided for power on/off, contrast, and brightness.

### 2.7.4 Connectors for Video Monitor

Video signal input and output shall be by BNC connectors.

### 2.7.5 Color Video Monitor (12-Inch)

All electronic components and circuits shall be solid state except for the picture tube. The monitor shall have a stabilized high voltage power supply, and regulated low voltage power supplies. The monitor shall have automatic frequency control (AFC) and horizontal resolution not less than 280 lines at the center of the picture tube. The video input shall allow switchable loop-through or 75 ohm termination. The monitor shall have circuitry for automatic degaussing. The monitor shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 105 to 130 volts.

### 2.7.6 Picture Tube

The monitor shall have a 12 inch picture tube measured diagonally.

### 2.7.7 Configuration

The monitor shall be configured in a desk or wall mount as shown. Monitors shall not interfere with each other when rack mounted or operated next to each other as described in EIA ANSI/EIA-375-A.

### 2.7.8 Controls

Front panel controls shall be provided for power on/off, horizontal hold, vertical hold, contrast, and brightness. The monitor shall have switchable DC restoration.

#### 2.7.9 Connectors for Video Monitor

Video signal input and output shall be by BNC connectors.

#### 2.8 VIDEO SWITCHER

The switcher shall conform to EIA 170 specifications, and shall be a vertical interval switcher. Electronic components, subassemblies, and circuits of the switcher shall be solid state. The switcher shall be microprocessor based and software programmable. Switcher components shall operate on 120 volts 60 Hz AC power. All components, modules, cables, power supplies, software, and other items needed for a complete and operable CCTV switching system shall be provided.

#### 2.9 VIDEO MULTIPLEXER/RECORDER

- a. The video multiplexer/recorder shall be a multi-channel record and playback system with the capability of monochrome and color real time multi-screen viewing. Electronic components, sub assemblies, and circuits of the multiplexer shall be solid state. The multiplexer, using time division multiplexing, shall permit up to 16 camera inputs to be recorded simultaneously. All 16 camera inputs shall be capable of being viewed on a video monitor either live or recorded. The multiplexer shall allow for simultaneous viewing, recording playback, and multiplexing (Duplex Operation). The inputs shall be capable of simultaneous viewing on the monitor or full screen individually and in other multi-screen modes such as 2x2, 3x3, 4x4 or other configurations. The viewing format shall also permit 2x dynamic zoom capability, full screen. The multiplexer shall be compatible with EIA/NTSC video cameras. External camera synchronization shall not be required for proper operation of the video multiplexer. Control of all functions of the multiplexer shall be provided either by a full function keyboard. The multiplexer shall retain the current program for at least 6 hours in the event of power loss.
- b. Video multiplexer/recorder shall have a selectable record rate of 30, 15, 10, 7.5, 6, 5, 4, 3, 2, 1, 1/2, 1/5 and 1/10 images per second (IPS) utilizing wavelet image compression at a color resolution of 720 x 484. Video multiplexer/recorder shall utilize video authentication to detect any alteration of recorded video. Provide 320 GB internal storage.

##### 2.9.1 Connectors

Video signal input and output shall be by BNC connectors.

#### 2.10 DIGITAL VIDEO RECORDER

- a. The digital video recorder shall be a single channel digital video recorder that records camera signals while simultaneously providing live multiscreen viewing and playback. The manufacturer shall offer the recorder with internal disk storage capacities of 80 GB.
- b. The recorder shall be designed using wavelet technology and produce file compression sizes selectable as 40 kB (high quality), 24 kB (medium quality), and 16 kB (standard quality).



- c. The recorder shall provide on-screen menu selection of the following languages: English, German, Dutch, French, Spanish, Italian, Polish, and Portuguese.
- d. The recorder shall maintain all system programming, including the date and standard/daylight saving time as programmed, in the event main power to the unit is lost.
- e. The system shall provide the following tow modes of recording:
  - 1) Continuously record to the disk until it is full, and then overwrites the oldest data. If the application requires, the system shall provide overwrite protection of the latest files for a period of 1 day up to 15 weeks. This overwrite protection period shall be manually selectable during record setup.
  - 2) Record to the disk and provide a warning when the disk is nearly full, and then stop recording when the disk is full. Display a disk-full alert on the main monitor and sound an alarm beeper. Older recordings must then be manually deleted.
- f. The images per second (IPS) rate and image quality shall be selectable for each connected camera as described below:
  - 1) The NTSC system version digital recorders allow selectable image per second (IPS) record rates of 30, 20, 10, 6, 1, 1/2, 1/5, 1/10.
- g. The recorder shall provide video loss detection to indicate the loss of a video input signal.
- h. The recorder shall provide the following monitor output:
  - 1) A main monitor output provides composite video that displays full-screen live or playback camera pictures.
- i. All video inputs shall be auto-terminating, loop-through BNC connectors.

## 2.11 VIDEO SIGNAL EQUIPMENT

The following video signal equipment shall conform to EIA 170. Electrically powered equipment shall operate on 120 Volts 60 Hz AC power. All video signal inputs and outputs shall be by BNC connectors.

### 2.11.1 Ground Loop Corrector

The ground loop corrector shall eliminate the measured ground loop interference (common mode voltage) in wireline or coaxial video transmission lines. The ground loop corrector shall pass the full transmitted video bandwidth with no signal attenuation or loss. Clamping ground loop correctors shall be capable of rejecting at least an 8 volt peak-to-peak 60 Hz common mode signal. Ground isolation transformers shall be capable of rejecting at least a 10 volt peak-to-peak 60 Hz common mode signal. Ground isolation amplifiers shall be capable of rejecting at least a 30 volt peak-to-peak 60 Hz common mode signal. Differential ground loop correctors shall be capable of rejecting at least a 100 volt peak-to-peak 60 Hz common mode signal.

### 2.11.2 Master Video Sync Generator

The master video sync generator shall generate horizontal drive, vertical drive, blanking, and sync signals as a minimum, with at least one 75 ohm output provided for each signal. The master oscillator crystal shall be pre-aged, and temperature stabilized, ovenized or temperature compensated. The sync generator shall have a composite video input and shall lock to the incoming video signal. If no video is present at the video input, the sync generator shall switch to internal crystal control. Not less than 2.5 microseconds advance and 2.5 microseconds delay of horizontal phase shall be provided. Vertical blanking width adjustment shall be provided. Vertical blanking width adjustment shall have a minimum selection range of 19, 20, and 21 lines.

### 2.11.3 Video Sync Distribution Amplifier

The sync distribution amplifier shall be a regenerative amplifier designed to distribute a sync signal input to not less than 6, 75 ohm outputs. Output level shall remain constant and shall not be affected by input level variations. Output isolation shall be greater than 35 dB at 5 MHz. A high impedance loop through shall be provided in addition to the 6 outputs. The distribution amplifier shall have continuously variable delay range of at least 250 nanoseconds to 2.2 microseconds. The delay shall be adjustable through a front panel control.

## 2.12 ACCESSORIES

### 2.12.1 Video Conference Shelf

Video conference shelf shall be a wall mounted, metal shelf with black epoxy finish and vertical/horizontal adjustment bracket.

### 2.12.2 Wall Outlets

Wall outlets shall be stainless steel device plates with through type BNC connectors. Provide number of connectors as required by outlet location.

### 2.12.3 Surge Suppressors

Provide low voltage surge suppression devices to suppress all voltage transient which might damage components. Mount suppressors in separate enclosures next to the equipment to be protected.

#### 2.12.3.1 Coax Cable Suppressors

Provide coax cable suppressors for all cables terminating on exterior cameras. Provide suppressor on each end of cable to protect camera and interior equipment. Suppressor shall have the following additional features as a minimum:

- a. Minimum surge current: 5 kA, 8/20 ms
- b. Clamp voltage: 6 volts
- c. Insertion loss: approximately 0.1 dB
- d. Impedance: 75 ohm nominal
- e. Connectors: BNC
- f. Listing: UL 497B

#### 2.12.3.2 Camera Power Suppressors

Provide surge suppressors for all camera power circuits terminating on exterior cameras. Provide suppressors on each end of cable to protect camera and interior power supplies. Suppressors shall have the following minimum additional features:

- a. Minimum surge current: 4 kA, 8/20 ms
- b. Clamp voltage: 30 VAC
- c. Connectors: Screw terminal
- d. Listing: UL 497B

#### 2.12.4 Fiber Optic Transmission System

The fiber-optic link shall provide simplex transmission of video. Input video signal shall be 1 V p-p composite video. The video bandwidth shall be 6 MHz. Optical wavelength shall be 1300 nm. Maximum optical attenuation with 62.5-um cable shall be 13 dB. Video signal-to-noise ratio shall be 55 dB minimum. The transmitter and receiver shall be standalone surface-mount modules.

#### 2.12.5 Multicamera Power Supply

Multicamera power supplies shall provide 28V power to cameras, and camera heaters. Power supply shall connect to 120 VAC power source and have terminals for 120 VAC input. Power supply shall be sized for the connected camera and heater load, plus 25 percent spare capacity. Each camera connection shall be individually fused. Power supply shall be housed in a metal enclosure with hinged door and lock.

#### 2.12.6 Equipment Console

- a. Configuration: Comply with EIA-310-D. Factory-fabricated units designed for interchangeable mounting, forced or convection air cooling, wiring connection, and enclosure of standard 19-inch relay rack modules.
- b. Mounting Provisions: Equipped for desk top mounting.
- c. Cabinet: Factory-finished steel with component mounting rails and pre-wired plug strips for component power connections. Full door with continuous hinges, handles, and cylindrical keyed locks.
- d. Verify the depth of each rack prior to assembly to ensure that mounted equipment will fit completely inside with the front or rear doors closed.
- e. Use blank panels or vent panels to fill all unused equipment mounting spaces.

#### 2.13 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government Furnished Equipment. All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.

### 2.13.1 CCTV Equipment Video Signal Wiring

The coaxial cable shall have a characteristic impedance of 75 ohms plus or minus 3 ohms. RG 59/U coaxial signal cable shall have shielding which provides a minimum of 95 percent coverage, a solid copper center conductor of not less than 23 AWG, polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket. RG 6/U coaxial cable shall have shielding which provides a minimum of 95 percent coverage, with center conductor of 18 AWG or larger polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket.

### 2.13.2 Low Voltage Control Wiring

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.009 inch. Cables shall be jacketed with a fluoropolymer compound. The jacket thickness shall be 0.02 inch minimum.

### 2.13.3 Digital Data Interconnection Wiring

Interconnecting cables carrying digital data between equipment located at the security center or at a secondary control/monitoring site shall be not less than 20 AWG and shall be stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100 percent coverage. Cables with a single overall shield shall have a tinned copper shield drain wire. Plenum or riser cables shall be IEEE C2 CL2P certified.

## 2.14 PREDELIVERY TESTING

### 2.14.1 General

The Contractor shall assemble the test CCTV system as specified, and perform tests to demonstrate that the performance of the system complies with the contract requirements in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during predelivery testing, including results of each test procedure, shall be delivered to the Government at the conclusion of predelivery testing prior to Government approval of the test. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.

### 2.14.2 Test Setup

The Contractor shall provide the equipment needed for the test setup and shall configure it to provide alarm actuated camera call-up and alarm recording as required to emulate the installed system. The test setup shall consist of at least 4 complete camera circuits. The alarm signal input to the CCTV test setup shall be by the same method that is used in the installed system. The video switcher shall be capable of switching any camera to any monitor and any combination of cameras to any combination of monitors. The minimum test setup shall include:

- a. Four video cameras and lenses, including dome cameras if required for the installed system.

- b. Three video monitors.
- c. Video recorder if it is required for the installed system.
- d. Video switcher including video input modules, video output modules, and control and applications software.
- e. Video multiplexer, if required for the installed system.
- f. Alarm input panel if required for the installed system.
- g. Pan/tilt mount and pan/tilt controller if the installed system includes cameras on pan/tilt mounts.
- h. Any ancillary equipment associated with a camera circuit such as equalizing amplifiers, video loss/presence detectors, terminators, ground loop correctors, surge protectors or other in-line video devices.
- i. Cabling for all components.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system. Raceways shall be furnished and installed as specified in Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and Section 16415A ELECTRICAL WORK, INTERIOR. DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. All other electrical work shall be as specified in the above sections including grounding to preclude ground loops, noise, and surges from adversely affecting system operation.

##### 3.1.1 Current Site Conditions

The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

##### 3.1.2 Existing Equipment

The Contractor shall connect to and utilize existing video equipment, video and control signal transmission lines, and devices as shown. Video equipment and signal lines that are usable in their original configuration without modification may be reused with Government approval. The Contractor shall perform a field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into the CCTV system, and furnish a report to the Government as part of the site survey report as defined in paragraph "Group II Technical Data Package." For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional

requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

#### 3.1.3 Enclosure Penetrations

All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

#### 3.1.4 Cold Galvanizing

All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

#### 3.1.5 Interconnection of Console Video Equipment

The Contractor shall connect signal paths between video equipment with RG-6/U coaxial cable. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

#### 3.1.6 Cameras

The Contractor shall install the cameras with the proper focal length lens as indicated for each zone; connect power and signal lines to the camera; set cameras with fixed iris lenses to the proper f-stop to give full video level; aim camera to give field of view as needed to cover the alarm zone; aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun; focus the lens to give a sharp picture over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

#### 3.1.7 Monitors

The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power.

### 3.1.8 Switcher

The Contractor shall install the switcher as shown and according to manufacturer's instructions; connect all subassemblies as specified by the manufacturer and as shown; connect video signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown; connect the switcher CPU and switcher subassemblies to AC power; load all software as specified and required for an operational CCTV system configured for the site requirements, including data bases, operational parameters, and system, command, and application programs; provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test; and program the video annotation for each camera.

### 3.1.9 Video Recording Equipment

The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

### 3.1.10 Video Signal Equipment

The Contractor shall install the video signal equipment as specified by the manufacturer and as shown; connect video or signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as required; connect control signal inputs and outputs as required; and connect electrically powered equipment to AC power.

### 3.1.11 Camera Housings, Mounts, and Poles

The Contractor shall install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site; provide a foundation for each camera pole as specified and shown; provide a ground rod for each camera pole and connect the camera pole to the ground rod; connect signal lines and AC power to mount interfaces; and connect pole wiring harness to camera.

## 3.2 SYSTEM STARTUP

The Contractor shall not apply power to the CCTV system until the following items have been completed:

- a. CCTV system equipment items and DTM have been set up in accordance with manufacturer's instructions.
- b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
- c. System wiring has been tested and verified as correctly connected as indicated.
- d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.

- e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.
- f. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

### 3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The following requirements supplement the contractor quality control requirements specified elsewhere in the contract. The contractor shall provide the services of technical representatives who are thoroughly familiar with all components and installation procedures of the installed IDS; and are approved by the Contracting Officer. These representatives will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet its contractual requirements.

### 3.4 SITE TESTING

#### 3.4.1 General

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test.

#### 3.4.2 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies in the terrain which may cause blind spots. Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Contracting Officer. The tape shall be recorded using the



video recorder installed as part of the CCTV system. If a recorder is not part of the CCTV system, the Contractor shall provide the tape in Video Home System (VHS) format. The Contractor shall provide the Government with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

- a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
- b. When the system includes remote control/monitoring stations or remote switch panels, verification that the remote devices are functional, communicate with the security center, and perform all functions as specified.
- c. Verification that the switcher is fully functional and that the switcher software has been programmed as needed for the site configuration.
- d. Verification that switcher software is functioning correctly. All software functions shall be exercised.
- e. Verification that video multiplexers are functioning correctly.
- f. Operation of all electrical and mechanical switcher controls and verification that the control performs the designed function.
- g. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
- h. Verification that all video signals are terminated properly.
- i. Verification that all cameras are aimed and focused properly. The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.
- j. Verification that cameras facing the direction of rising or setting sun are aimed sufficiently below the horizon so that the camera does not view the sun directly.
- k. If vehicles are used in proximity of the assessment areas, verification of night assessment capabilities and determination if headlights cause blooming or picture degradation.
- l. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.
- m. Verification that the alarm interface to the IDS is functional and that automatic camera call-up is functional with appropriate video annotation for all designated ESS alarm points and cameras.
- n. When pan/tilt mounts are used in the system, verification that the limit stops have been set correctly. Verification of all controls for pan/tilt or zoom mechanisms are operative and that the controls perform the desired function. If preposition controls are used, verification that all home positions have been set correctly, and have been tested for auto home function and correct

home position.

- o. When dome camera mounts are used in the system, verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.

The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

#### 3.4.3 Performance Verification Test

The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Government, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. If the CCTV system is being installed in conjunction with an ESS, the CCTV performance verification test shall be run simultaneously with the ESS performance verification test. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

#### 3.4.4 Endurance Test

- a. The Contractor shall demonstrate the specified requirements of the completed system. The endurance test shall be conducted in phases as specified. The endurance test shall not be started until the Government notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. If the CCTV system is being installed in conjunction with an ESS, the CCTV performance verification test shall be run simultaneously with the ESS performance verification test. The Contractor shall provide one operator to operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing, in addition to any government personnel that may be made available. The Government may terminate testing at any time the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test the Contractor shall verify the operation of each camera. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.
- b. Phase I (Testing): The test shall be conducted 24 hours per day

for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during Phase I testing, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

- c. Phase II (Assessment): After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, or may require that Phase I be repeated. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.
- d. Phase III (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.
- e. Phase IV (Assessment): After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, and may require that Phase III be repeated. The Contractor shall not commence any required retesting until after receipt of written notification by Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.
- f. Exclusions: The Contractor will not be held responsible for failures resulting from the following:
  - (1) An outage of the main power supply in excess of the capability

of any backup power source, provided that the automatic initiation of all backup sources was accomplished.

(2) Failure of a Government furnished DTM circuit, provided that the failure was not due to Contractor furnished equipment, installation, or software.

(3) Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

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SECTION 16785A

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## SECTION 16785A

## TELEVISION DISTRIBUTION SYSTEM

10/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/TIA/EIA-222-F (1996) Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

## NATIONAL CABLE TELECOMMUNICATIONS ASSOCIATION (NCTA)

NCTA RP (2002) NCTA Recommended Practices for Measurements on Cable Television Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 780 (2000) Installation of Lightning Protection Systems

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

47 CFR 25 Satellite Communications

47 CFR 76 Multichannel Video and Cable Television Service

## UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; Rev thru Feb 2001) Grounding and Bonding Equipment

UL 1581 (2001; Rev thru May 2003) Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 969 (1995; Rev thru Nov 2001) Marking and Labeling Systems

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Standard Products

Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design in satisfactory use for at least 2 years prior to bid opening.

### 1.2.2 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

### 1.2.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

### 1.2.4 Verification of Dimensions

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Distribution Equipment; G, RE

System design drawings conforming to NCTA RP. Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Detail drawings shall contain complete wiring and schematic diagrams, equipment layout and anchorage, and other details required to demonstrate that the system has been coordinated and will function properly as a unit.

#### SD-03 Product Data

##### System Calculations; G, RE

System calculations, 45 days prior to proposed installation start date. The calculations shall encompass the losses and gains for the various components of the system, including cable runs. The Contractor shall establish the required signal strengths for each component of the signal reception system and shall verify each with respect to signal strength and quality.



Testing; G, RE

Test procedures and plans, 30 days prior to proposed test date. The plan shall conform to NCTA RP and other applicable codes, regulations, and manufacturer requirements. The plan shall include proposed methods of documenting test results.

#### SD-06 Test Reports

Testing; G, RE

Test reports in booklet form showing field tests performed to adjust each component and acceptance tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of the controls.

#### SD-10 Operation and Maintenance Data

Signal Reception System; G, RE

Six copies of each manufacturer's operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include equipment layout and schematics of simplified wiring and control diagrams of the system as installed, the manufacturer's name, model number, and a brief description of equipment and components and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The manual shall include equipment layout and schematics and simplified wiring and control diagrams of the system as installed.

### 1.4 SYSTEM DESCRIPTION

The television signal reception system shall receive radio frequency (RF) signals available from cable television provider for transmission to the outlet via a coaxial cable distribution system. The system shall utilize industry standard, commercially available solid-state electronic passive and active devices to receive and distribute the RF signals to each outlet and meet the specifications and requirements listed herein. The system shall comply with 47 CFR 15, 47 CFR 25, and 47 CFR 76. The equipment used shall be designed for commercial and industrial applications. The system shall be designed to provide continuous entertainment on a series of cable television channels 2 to 117. System calculations shall be performed to establish taps, amplifier settings, etc.

#### 1.4.1 System Configuration

The system shall consist of passive and active cable distribution equipment and head end equipment.

##### 1.4.1.1 Cable Distribution System

The cable distribution system shall consist of coaxial cables, outlets and hardware including signal splitters, distribution amplifiers, signal equalizers, power supplies, fiber optic converters, taps, and other ancillary hardware.

#### 1.4.1.2 System Hardware Design

System hardware shall be solid state and shall utilize modular components to provide maximum flexibility, ease of maintenance, and ease of expansion where practicable. Solid state and integrated circuitry containing silicon-based materials shall be employed to the maximum practicable extent. Mechanical and electro-mechanical relays, tuning controls, and other mechanical components and parts shall not be used where the necessary functions can be performed in a more reliable manner by electronic components.

#### 1.4.1.3 Maintenance Accessibility

Parts which require periodic service or maintenance shall be easily accessible. Components in the head end equipment requiring tuning adjustments shall be externally accessible from the front of the equipment and racks.

#### 1.4.1.4 Configuration and Future Expansion

The system shall accommodate future expansion with minimum service interruption.

- a. The distribution equipment shall be configured as indicated. Components in the distribution system shall, as a minimum, be capable of distributing 35 CATV channels (2 - W(36) low, mid, high and super band).

#### 1.4.2 System Performance

The system shall be capable of receiving broadcast signals from the local cable television provider. Coordinate signal level into building with local cable television provider. The system shall deliver to all user outlets the performance specified in TABLE IIa.

### 1.5 TELEVISION INPUT INTERFACE

Interfaces shall be according to the following tables:

TABLE IIa. TELEVISION RECEIVER INPUT INTERFACE

Impedance:	75 ohms unbalanced
RF Video Carrier Level:	
Minimum	3 dBmV
Maximum	12 dBmV
Relative RF Video Carrier Level:	Within 3 dB to adjacent channel All channels within 12 dB
Carrier Level	
Stability:	
Short-term (1 hour)	Within 0.5 dB maximum
Long-term (24 hours)	Within 2.0 dB maximum
Frequency range (MHz):	54-750 MHz
Frequency Response:	

TABLE IIa. TELEVISION RECEIVER INPUT INTERFACE

Peak to valleys for system bandpass	Plus or minus 3 dB
Across any 6 MHz channel referenced to video carrier plus 200 kHz sideband amplitude	Plus or minus 1 dB
Carrier to Noise Ratio:	Greater than or equal to 45 dB
Cross Modulation (NTCA Test Method):	Less than minus 50 dB
Carrier to Echo Ratio:	Greater than 40 dB
Composite Triple Beat:	Less than minus 53 dB
Second Order:	Less than minus 60 dB
Terminal Isolation:	
Minimum TV-TV	25 dB
Minimum TV-FM	35 dB
Hum Modulation (maximum):	2 percent (equivalent to minus 40 dB sidebands)

#### 1.6 DELIVERY AND STORAGE

Equipment shall be delivered in original packages with labels intact and identification clearly marked. Equipment and components shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

#### 1.7 ENVIRONMENTAL CONDITIONS

System components located inside buildings shall conform to the specified performance when subjected to any combination of the following environmental conditions:

Temperature: At 40 to 100 degrees F.

Relative humidity: From 0 to 95 percent (no water condensation).

### PART 2 PRODUCTS

#### 2.1 PROCESSOR

A processor shall be provided for each channel translation shown. Processors for channel translation shall as a minimum conform to the following specifications:

Bandwidth: 6 MHz

Input Range:	54 - 806 MHz, field selectable via front panel
Output Range:	54 - 550 MHz, field selectable via front panel
Impedance (input and output):	75 ohms
Return Loss (within 6 MHz bandwidth):	16 dB
Max. Noise Figure (at maximum gain):	10 dB
Input Level Range:	VHF minus 20 to plus 30 dBmV - UHF minus 20 to plus 25 dBmV
Output Level Range:	50 to 60 dBmV
Carrier to Noise Ratio (with plus 10 dBmV input):	57 dB
AGC Regulation:	Plus or minus 1 dB output variation for rated input level range variation
Frequency Stability:	Plus or minus 10 KHz over operational temperature range
Spurious Output:	60 dB below video carrier with video carrier output level at plus 60 dBmV and audio carrier level at plus 45 dBmV.
Adjacent Channel Rejection:	Equal to or greater than 60 dB

## 2.2 COAX TO FIBER AND FIBER TO COAX CONVERTERS

- a. Coax to Fiber Converter: Coax to fiber converter shall transmit TV channels over 1310 nm single mode fiber to fiber to coax converter.

- 1) Band Width: 5 - 250 MHz
- 2) Coax Input: 75 ohms
- 3) Optical Input: 3 dBm
- 4) Power: Provide 120 vac to DC power supply
- 5) Operating Temperature Range: 50 degrees F to 104 degrees F
- 6) Mounting: Wall or rack as shown

- b. Fiber to Coax Converter: Coax to fiber converter shall receive TV channels over 1310 nm single mode fiber from coax to fiber converter.

- 1) Band Width: 5 - 250 MHz
- 2) Coax Output: 75 ohms
- 3) Input Power: 9 dBm
- 4) Carrier to Noise Ratio: 49 dB minimum

- 5) Composite Tripe Beat: -63 dB maximum
- 6) Composite Second Order: -70 dB maximum
- 7) Power: Provide 120 vac to DC power supply
- 8) Operating Temperature Range: 50 degrees F to 104 degrees F
- 9) Mounting: Wall or rack as shown

c. Fiber optic cable shall comply with Section 16710A, PREMISES DISTRIBUTION SYSTEM.

## 2.3 TRAPS

Traps shall be designed to reject any transmission interfering with desired signal reception.

## 2.4 ATTENUATORS

Provide attenuators to equalize signal levels, when required. Variable attenuators are not permitted.

## 2.5 SPLITTERS/COMBINERS

Use splitters/combiners with characteristics equal to or exceeding the characteristics listed in this paragraph over the entire operating band. All unused outlets must be terminated with 75-ohm terminators.

- a. Slope: 0.8 dB.
- b. Return Loss: 15 dB.
- c. Band Width: 5 - 1,000 MHz.

## 2.6 TERMINATORS

Terminators shall be rated for 75 ohms and 1/4 watt and shall be equipped for power blocking.

## 2.7 LINE TAPOFFS

Line tapoffs shall have 18 dB minimum isolation from each tap to the thru-line. Pressure tapoffs are not permitted.

- a. Band Width: 5 - 1,000 MHz.
- b. Peak to Valley: 1 dB at 1 GHz.

## 2.8 OUTLETS

Provide flush mounted, 75-ohm, F-type connector, stainless steel walltaps. Provide flush-mounted walltaps mounted in standard electrical outlet boxes.

## 2.9 COAXIAL CABLE CONNECTING KITS

Six feet, 75-ohm "F" fittings connected to a 300-ohm spadetip matching transformer.

## 2.10 WALL MOUNTED OPEN FRAME

Wall mounted open frame equipment rack shall be steel relay rack with uprights to mount equipment 19 inches wide and standoff brackets for wall mounting. Standoff brackets shall be of sufficient length for a 6 inch clearance between rack and wall. Uprights shall be drilled and tapped 12-24 in a 1/2 inch pattern. Rack shall be hinged. Rack shall be painted.

Color shall be the manufacturer's standard.

## 2.11 EQUIPMENT BACKBOARD

Equipment backboard, where shown, shall be Type ACX plywood coated on both sides with at least two coats of fire resistant overcoat, sized and located as shown.

## 2.12 DISTRIBUTION AMPLIFIER

Distribution amplification shall be provided as required to deliver the minimum signal parameters specified in paragraph SYSTEM DESCRIPTION and TABLE IIb to user interfaces. Distribution amplifier shall be designed for heavy duty commercial and industrial applications. As a minimum, amplifier shall be contained in a wall-mountable steel or aluminum housing, vented or finned for convection cooling. Amplifier cable ports shall be "F" type. Amplifier shall be powered by a 120 Vac, 60 Hz source.

## 2.13 CABLES AND ASSOCIATED HARDWARE

Cabling shall be UL listed for the application and shall comply with NFPA 70.

Provide a labeling system for cabling as required by UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

### 2.13.1 Feeder Cable

UL 1581, provide RG-11 coaxial trunk cable with an NFPA 70 rating of CATVP and the following characteristics:

- a. #14 AWG copper-clad steel center conductor.
- b. Foam FEP dielectric with .28 inches nominal outer diameter.
- c. Bonded foil inner-shield and a minimum of 60 percent aluminum braid or quad shield.
- d. 75 ohms impedance.
- e. 81 to 84 percent nominal velocity of propagation.
- f. PVC low smoke polymer or FEP jacket.
- g. Maximum attenuation characteristics:

MHz	DB/100 ft
50	1.2
100	1.7
200	2.5
400	3.5
700	4.6
900	5.3
1000	5.6

### 2.13.2 Drop Cable

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of CATVP and with the following characteristics:

- a. No. 18 AWG copper-clad steel center conductor.
- b. Bonded foil inner-shield and 90 percent aluminum braid.
- c. Characteristic impedance of 75 ohms.
- d. Foam FEP dielectric.
- e. Nominal capacitance, conductor to shield, of 16.2 pf per 100 ft.
- f. Maximum operating voltage of 350 V RMS.
- g. Maximum attenuation:

## CATVP

MHz	DB/100 ft	MHz	DB/100 ft
10	0.7	900	6.9
50	1.5	1000	7.3
100	2.1		
200	3.1		
400	4.5		
700	6.0		

- h. PVC low smoke polymer or FEP jacket.
- i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

## 2.14 TILT COMPENSATOR

Provide tilt compensators as required.

## 2.15 MUTLI-TAPS

Multi-taps shall output as shown and have a minimum of 14 dB isolation from each tap to the thru-line.

- a. Band Width: 5 to 1,000 MHz.
- b. Peak to Valley: 1 dB to 1 GHz maximum.

## 2.16 GROUNDING BLOCK

Provide grounding block suitable for indoor installation.

## PART 3 EXECUTION

## 3.1 INSTALLATION

Interior installations shall comply with NFPA 70. Exterior installations shall comply with IEEE C2, NFPA 70, and NFPA 780. System components shall be installed and tested in accordance with the manufacturer's specifications and recommendations.

## 3.1.1 System Components

The Contractor shall configure the system components in a manner consistent

with the manufacturer's specifications. The distribution system configuration and placement shall conform to available cable routing and proposed equipment locations as shown.

### 3.1.2 Components

Amplifiers, combiners, splitters, and power supplies shall be located in a secured area on the specified equipment backboard or rack mounted as shown.

### 3.2 GROUNDING

Grounding shall be in accordance with applicable portions of NFPA 70, NFPA 780, IEEE C2, UL 467 and EIA ANSI/TIA/EIA-222-F. Maximum resistance to ground at the connection point for system components shall be 25 ohms. Grounding conductor shall be minimum No. 6 AWG solid copper. Existing tower, if utilized, shall be made to conform to the above requirements. System components shall have a direct connection to ground. Each cable shall be grounded at the point of building entry with a grounding block or shall be equipped with a surge protector to dissipate electrical surges. Grounding block shall be directly connected to a driven ground. Head end equipment shall be equipped with surge protection by either inherent design or external device. Unless otherwise specified, lightning and transient surge protection shall be provided in accordance with NFPA 780.

### 3.3 FIELD TRAINING

The Contractor shall conduct training courses for operating and maintenance staff designated by the Government. The training course will be given at the installation during normal working hours for a total of 8 hours for 4 persons and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals, as well as demonstrations of routine maintenance operations. The Government shall be notified at least 14 days prior to start of the training courses.

### 3.4 TESTING

The Contracting Officer shall be notified 20 days before the system is ready for acceptance tests. Acceptance tests shall not be conducted until the system has experienced 30 days of satisfactory operation, the last 20 days of which shall have been with no component failures. Acceptance tests shall be performed in accordance with the approved Test Plan, shall conform to NCTA RP, and shall be conducted in the presence of the Government. Instruments, personnel, and transportation required for the tests shall be provided by the Contractor.

#### 3.4.1 Cable Testing

After installation of the cable and before connection to system components, each cable section shall be tested using a time domain reflectometer (TDR) to determine shorts, open, kinks, and other impedance discontinuities and their locations. Cable sections showing adverse impedance discontinuities (defined as greater than 6 dB loss) shall be replaced at the Contractor's expense. There shall be no cable splices between system components unless approved by the Government.

#### 3.4.2 System Testing

An end-to-end system test shall be conducted to determine if the system



performance requirements have been met. Tests shall also be performed on randomly selected equipment, components, and modules selected at the time of testing by the Government, to determine if the system meets the specified requirements. Deficient portions of the system shall be repaired and retested at the Contractor's expense.

-- End of Section --